ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XXXV., No. 17.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK..... 265, 280
The Ruthven Wagon Loader (illustrated)..... 266
Efficiency of Nozzles for Small Water Motors (illustrated)..... 266
The Claims of the Contractors for the New Croton Aqueduct..... 267
The Statistics of Mineral and Metal Production in the United States in 1895..... 268
Barrow Car and Transfer Car for Handling Broken Stone, etc. (illustrated)..... 268
The Semi-Centennial of the Pennsylvania R. R. Co. 269
A Combination Lock without a Dial (illustrated).. 269
A New Dynamometer for Measuring Power Absorbed in Driving Machinery (illustrated)..... 270
A Fly-Wheel Built of Steel Plates (illustrated).... 270
Maintenance of a Separate System of Sewers.... 270
Weather Report for March..... 271
Legal Decisions of Interest to Engineers..... 271
The Waterous Fire Hydrant (illustrated)..... 275
A Spring Seat Bicycle (illustrated)..... 276
An Electro-Mechanical Water-Wheel Governor (illustrated)..... 276
Hydraulic Suction Dredge for the Navigation Improvements of the Mississippi River (illustrated, with inset)..... 277
Yard Tests of Air Brakes..... 279
The Pencoyd Iron Works New 18-in. Beams (illustrated)... 279
EDITORIAL NOTES 272, 273
The Greatest Dredge in the World—A Proposal to Connect Existing Government Surveys—A Department of Commerce and Manufactures—The Claims of the Croton Aqueduct Contractors—The Design for the Montreal Bridge—Reforms in the Institution of Civil Engineers.
EDITORIAL..... 273
The Work of the Texas State Railway Commission.
LETTERS TO THE EDITOR..... 274, 275
The Significance of the Term "Factor of Safety"—Formulas for Computing Angles with Unequal Legs—The Efficiency of the Compressed Air Power Plant at Grass Valley, Cal.—Amount of Paint and Labor Required in Painting a Train Shed Roof—The Providence Experiments on the Mechanical Filtration of Water—Engineering as a Close Profession—Engineering Nomenclature Again—The Steel Manufacturers' Specifications for Steel—improving the Mississippi River by Contract.

THE COST OF TIES IN NEW ENGLAND, as taken from the reports of the State Boards of Railroad Commissioners of Connecticut and Maine, for 1895, are given below in tabular form, and may be compared with the similar figures for Texas, given in our issue of March 19.

	Connecticut.		Maine.	
	Range.	Ave.	Range.	Ave.
Cedar			20 to 36¼	28
Chestnut	35 to 48	41½	44 to 45	44½
Hackmatack			18 to 30	24
Hemlock			16 to 26¾	21½
Juniper			21	21
Oak	36½ to 48	42½		
Pine	48	48	16 to 28	22
Tamarack			28½	28½
Bridge ties (pine)	69	69		
Switch ties (pine)	69	69	$1.00	$1.00
Second class (chest. & oak)	20 to 42	31		
Third class (" ")	22	22		

COVERING SAND BALLAST WITH BROKEN STONE, to prevent dust, has been successfully tried on the Orleans railway, of France. For 214 miles this road is ballasted with fine sand, which envelops all express trains in a thick cloud. Stone is too scarce and costly to be used for ballast, instead of the sand, and an attempt to promote the growth of a species of grass over the track failed because in repairs the vegetable mold was soon mixed with the sand. In 1888, it was decided to cover the sand with a 2½-in. bed of stone broken to pass through a 2¼-in. ring. The excess sand was removed and the stone carefully spread and packed. In case of repairs a special steel fork is used to remove the stone from the surface and to put it back again. While the theoretic depth of the stone is 2½ ins., its actual depth is really greater. The roadbed presents the appearance of being ballasted with broken stone; the sand is well covered and the nuisance from dust has been abated. The cost is said to be only one-fourth of that of all stone ballast in the valley of the Loire. The company also reports an unknown but large saving in the maintenance of the rolling-stock, due to the suppression of the dust. The cost varied from $484 to $774 per mile of double track, according to the first cost of the stone. This practice has been in use in India for many years.

AN INSPECTION LOCOMOTIVE built for the Adirondack & St. Lawrence R. R. by the Schenectady Locomotive Works, of Schenectady, N. Y., is an eight-wheel engine having a cab extending to the smokebox. The saloon part of the cab is entered by steps in front of the cylinders, and is fitted with six chairs. The engine has an ordinary eight-wheel tender, and can haul a private car weighing 120,000 lbs. over the steepest grades on the line. The engine is fitted with Westinghouse brake on the driving, truck and tender wheels, Leach sanding apparatus, Gould couplers, Le Chatelier water brake and Boyer speed recorder. The general dimensions are as follows:

Driving wheels, diam.	5 ft. 2 ins.
Truck " "	2 " 4 "
Tender " "	2 " 9 "
Wheelbase, driving	7 " 4 "
" engine	20 " 10 "
" engine and tender	41 " 1 "
Weight on driving wheels	49,700 lbs.
" total, engine	78,700 "
" tender, empty	33,250 "
Cylinders	14 × 22 ins.
Steam ports	1⅞ × 12 "
Exhaust ports	2½ × 12 "
Boiler (wagon top), diam. of barrel	3 ft. 6 ins.
Boiler pressure	180 lbs.
Firebox	4 ft. 10 3-16 ins. × 2 ft. 10⅝ ins.
Grate area	13.89 sq. ft.
Tubes, 128, diam. (outside)	2 ins.
" length over tube plates	10 ft. 7 ins.
Heating surface, tubes	703.7 sq. ft.
" firebox	80.0 " "
" total	783.7 " "
Coal capacity of tender	5 tons
Water " "	2,500 gallons

THE TEN-WHEEL LOCOMOTIVES for the Russian government railways, built by the Baldwin Locomotive Works, of Philadelphia, Pa., are all four-cylinder compounds of the Vauclain system, and are all fitted for burning naphtha as fuel. The general dimensions are as follows:

Gage of track	5 ft. 0 ins.
Driving wheels, diam.	6 " 0 "
Wheelbase, driving	14 " 0 "
" total	26 " 3 "
Weight in working order, on driving wheels	103,000 lbs.
" total	140,000 "
Cylinders, h. p. (2)	14 × 26 ins.
" l. p. (2)	24 × 26 "
Boiler	Straight top
" diameter of barrel	5 ft. 0 ins.
Firebox, length	6 " 8½ "
" width	3 " 0 "
Tubes, number, 223; diameter	2 "
" length	14 ft. 3 "
Heating surface, tubes	1,650 sq. ft.
" firebox	119 " "
" total	1,769 " "
Tank capacity, naphtha (fuel)	1,850 gallons
" water	3,700 "

A COMBINATION FREIGHT CAR, used on the Duluth, South Shore & Atlantic Ry., can be used as a hopper bottom ore car during the shipping season, and then converted into a flat or gondola car for lumber traffic during the winter. When used as an ore car, the end slopes of the hopper extend up through the body of the car to the top of the sides, but these sloping ends can be folded down over the hopper to form a flat bottom from end to end of the car. There are five sills, 5 × 10 ins., and four 1½-in. truss rods. The car is 8 ft. 6 ins. wide inside, 21 ft. 6 ins. long over the body, and 22 ft. over the end sills, to suit the spacing of the ore pockets at the shipping trestles. The body is mounted on two four-wheel trucks, with diamond frames, the truck wheelbase being 4 ft. 10 ins., and the trucks 13 ft. 8½ ins. c. to c. The car will carry about 27 to 30 tons of soft ore, and 30 to 33 tons of hard ore. The results have been so satisfactory that 600 cars of this type are now being built.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a derailment on the Canadian Pacific Ry., near Lowelltown, Me., April 20. A culvert had been undermined by floods and gave way under a special immigrant train from Halifax. The engine, baggage car and two colonist cars were derailed and three persons were killed.

THE OLD PENNSYLVANIA R. R. STATION at 32d and Market Sts., Philadelphia, Pa., was burned April 18, and about 8 Pullman cars and 30 passenger cars were destroyed. Two firemen were killed and 12 railway men and firemen injured by the falling walls. According to one report the fire was started by a gasoline tank in one of the cars, while another report is that it started at a coal bin in the car shed. Many valuable records, right of way plans, etc., were stored in a brick vault in the building and were entirely destroyed. The total loss of property is estimated at about $225,000.

AN EXPLOSION OF DYNAMITE occurred in the Broadwater mine, at Neihart, near Butte, Mont., April 18, killing seven and injuring six men. It is said the shock of the explosion of some cartridges which were being thawed caused the explosion of all the dynamite in the magazine.

SPECIFICATIONS FOR A NEW WATER SUPPLY FOR Jersey City were adopted by its Street and Water Board on April 20, and it was resolved to advertise for bids to be received May 18. The specifications were drawn by Mr. C. C. Vermeule, 71 Broadway, New York city, in conjunction with Mr. W. W. Ruggles, Chief Engineer of the Board. Mr. Vermeule has sent us the following synopsis of the specifications:

Specification A is for delivery of water into Bergen reservoirs, 127 ft. above mean high tide, by gravity, the high service supply being pumped by the city. Specification B is for delivery of water at Bergen reservoirs with a pressure equivalent to a head of 210 ft. above mean high tide, or so as to afford a high service supply and increased pressure without pumping. In other respects these two specifications are the same. The contract is to run for 25 years, the prices to be per million gallons delivered. The city agrees to take at least 20,000,000 gallons daily and take its whole supply from the contractor; capacity of works to be 35,000,000 gallons daily, and to be increased to 50,000,000 gallons daily when the city agrees to take at least 30,000,000 gallons daily. Pollution must be prevented by the contractor, but there is no chemical standard. The contractor must furnish a certified cheque for $100,000 with his bid, and a bond of $500,000 for faithful performance of his contract. Bidders must state a price at which the city can buy the plant at any time within 22 years. Specification C is for the filtration of the Passaic water by downward filtration through sand filter beds having an area of one acre for per 1,000,000 gallons daily to be filtered. The contractor must specify the parts of organic matter, of chlorine, of free ammonia, albuminoid ammonia and nitric acid, and the number of bacteria in one cubic centimeter of water delivered. He must also agree that the water shall contain no nitrites exceeding a trace, that it shall be free from color, odor, turbidity, alkaline or acid tastes. All other provisions are exactly the same as in Specifications A and B. The local conditions are not believed to be favorable for the success of mechanical filtration or any rapid process, and it will be observed that only bids for sand filtration are invited.

THE POLLUTION OF THE PASSAIC RIVER and means to prevent it are to be investigated by a commission which has just been appointed by Gov. Griggs, of New Jersey as follows: Dr. Elias J. Marsh, Mr. Wm. T. Hunt, and Dr. H. C. H. Herold. The commission has power to employ engineers and to expend $10,000 for the investigation, but all the expenditures must meet the approval of the governor.

THE RIGHT TO USE WATER FROM THE NIAGARA River, in unlimited quantity and without compensation to the State of New York, is claimed by the following six concerns: Lockport Water & Electric Co., Niagara County Irrigation & Water Co., Lewiston Water Supply Co., Buffalo and Niagara Power & Drainage Co., Niagara Power & Development Co., and the Niagara, Lockport and Ontario Power Co. The Commissioners of the Niagara Falls Reservation state that these companies now have legislative authority to take water from the river, and the Niagara Falls Power Co., chartered in 1886, is now actually drawing water from that source and is authorized to develop 200,000 HP., which will require 6% of the average flow of the river. Another company, the Hydraulic Power & Manufacturing Co., is enlarging its canal without authority, and has been taking water for many years. The Commissioners believe that the Falls will be seriously affected by these enterprises and they especially withhold their consent from the proposed increased appropriation to a total of 200,000 HP., demanded by the company last named.

THE MARYLAND AND DELAWARE FREE SHIP Canal is the subject of a bill introduced in the U. S. Senate by Senator Elkins. This canal would connect Chesapeake and Delaware Bays, and it would be not less than 100 ft. wide on the bottom and 30 ft. deep at mean low tide. The bill proposes its construction as a means of military and naval defense, and for commercial purposes, and an appropriation of $1,000,000 would be carried with it.

THE NICARAGUA CANAL PROJECT is still under investigation by the House Commerce Committee, and the last experts to testify before the committee were Mr. M. T. Endicott, Civil Engineer U. S. N.; and Mr. Alfred Noble, M. Am. Soc. C. E., both members of the Canal Commission sent to Nicaragua last year. Mr. Endicott detailed the work done by the Commission and says 34 days were consumed in actual field work by that board of officers. He thought the United States ought to own a canal connecting the two oceans, and he did not know of any more favorable route than the one under consideration; but he also thought that the United States did not possess a sufficient naval force to hold it in case of war with England. He maintained that to construct a canal of 28 ft. depth throughout would cost $133,000,000. He regarded the Tehuantepec route as better from a strategic standpoint, but it would cost more money than one through Nicaragua. He estimated the general plant of the canal company as worth about $500,000; the breakwater pier was worm-eaten and of little value; but the one mile of canal, excavated 16 ft. deep, was in good condition, as was the 11 miles of railway. Mr. Endicott considered the Ochoa dam feasible and safe, if it were not used as a weir. He considered the whole project feasible; but advised careful investigations on certain sections before work was commenced. Mr. Noble, in answer to questions, said that the prices put by the Commission upon its estimates had been obtained by careful consultation with those doing similar work in the United States. He believed that the canal could be properly built for the sum named by the Commission; but before he admitted that the route selected by the canal company was the best he would want to make further examinations. Mr. Noble had not consulted with officials in Nicaragua as to their altitude towards ownership of the canal by the United States; but he believed that the canal would be a commercial success.

THE RUTHVEN WAGON LOADER.

An apparatus for loading earth excavated by scrapers direct into wagons without the intervention of hand shoveling, is shown in the accompanying cut. The scrapers pass over a tilting platform on which they are dumped, and the table is then tilted up so as to throw the earth into a hopper from which it is raised by a bucket elevator, the buckets dumping the earth into chutes through which it falls into wagons drawn up at the sides. The machine is about 20 ft. long, exclusive of the platform, and 7 ft. wide over the wheels, the chutes projecting beyond the wheels so that the wagons can easily be pulled under them. The chutes are 4 ft. wide, so that the wagon has only to move once to take a full load. The platform is 7 ft. wide and 9 ft. long. Two scraper loads of ½ cu. yd. each are dumped upon it, and it is then raised, being off the ground only about 7 seconds. The elevator buckets hold 2 cu. ft. There are 22 of these buckets attached to an endless chain running at such a speed that over 100 bucket loads are discharged per minute. The engine is under the chute, and runs the elevator continuously and also lifts the platform when desired by means of a friction attachment.

The machine is the invention of Mr. R. C. Ruthven, Assistant Superintendent of the Barber Asphalt Paving Co., Buffalo, N. Y., and the company has built and used one of the machines at Buffalo. Mr. Ruthven states that it has loaded 35 to 40 wagons per hour, each wagon holding 2 cu. yds. level full, working in very stiff clay. There is a saving of three or more teams in hauling the earth to the dump, owing to the wagons being loaded in a little over a minute, and there is no loss in changing the wagons, as the chutes hold what is elevated during that time. The saving on street work was found to be about 10 cts. per cu. yd. as compared with men shoveling. The following is a table of the labor required, and cost of loadng from 500 to 800 cu. yds. per day on this system:

	No. of Men.	Expense.
Foreman	1	$3.00
Engineman	1	3.00
Firemen	1	1.50
Dumping scrapers	2	3.00
Loading wagons	2	3.00
Cleaning up	1	1.50
Loading scrapers	3	4.50
Scraper teams, five		18.75
Watchman	1	1.50
Water boy	1	1.00
On dumps	2	3.00
Plow teams, two		8.00
Plow men	2	3.50
Coal, 1,100 lbs.		2.00
Total, 7 teams	17	57.25
Saving of 3 teams by not having to stand long to be loaded		10.50
		$46.75

EFFICIENCY OF NOZZLES FOR SMALL WATER MOTORS.*

By Arthur B Ilsley, B. S., and Herbert R. Thurston, B. S., Graduates of the Thayer School of Civil Engineering, Dartmouth, N. H.

Owing to the general introduction of water under pressure into cities and towns, motors of comparatively small power can be used with advantage in very many places. They are excellently adapted for driving light machinery, being simple in design, easily managed and very efficient. The motor, in most cases, is simply a wheel enclosed in an iron case in which it revolves freely, carrying upon its rim buckets or vanes, against which jets of water impinge. The value of an efficient nozzle which forms the jet of water, seems to have been disregarded in the design of many motors.

The term, efficiency of the nozzle, herein used, means, strictly speaking, the coefficient of velocity, and were there any contraction of the stream after leaving the orifice, the area used should be the contracted area. But in the experiments there was no such contraction noticeable, and hence the term efficiency means also the coefficient of discharge. Neither must this term, as used here, be confounded with the efficiency of the Venturi tube. Here this is found by using the area and velocity always at the orifice, and hence is always less than unity; while with the Venturi tube the efficiency greater than unity is obtained by using the velocity and area at the smallest section.

The energy per unit of water discharged is proportional to the square of the efficiency of the nozzle, and the energy developed by the water in a unit of time is proportional to the cube of the efficiency of the nozzle. Water power from the street mains would nearly always be paid for by the quantity of water passing through the meter, and people buying or using motors would want to know the loss of energy per cubic foot of water due to nozzle efficiency. The percentage of work actually obtained from a given quantity of water consumed would be as follows:

Efficiency of nozzle	1.00	.90	.80	.70	.60	.50
Percentage of theor. work	100	81	64	49	36	25

Therefore, other things being equal, it would take four times as much water and eight times as long to do a given amount of work with a nozzle efficiency of .50 as it would with a nozzle efficiency of 1.00.

The nozzles experimented with were connected directly to the pipe by ordinary fittings, and only screwed on enough to obtain a tight joint. The pressure was measured by a Woodman gage having 5-lb. divisions. The pressure when indicated between two divisions, could be easily estimated, or by means of the valve it could be regulated to any division on the gage. The ¼-in. stem of the gage was screwed into the pipe behind the nozzle, care being taken not to have it project inside.

In the first experiments on the 2-in. pipe the gage was located 3 ft. behind and 6 ins. below the nozzle. The tables contain a correction for the head due to the location of the gage. During the experiments on the 1½-in. pipe, the gage was located 1 ft. behind the nozzle, and on the same level.

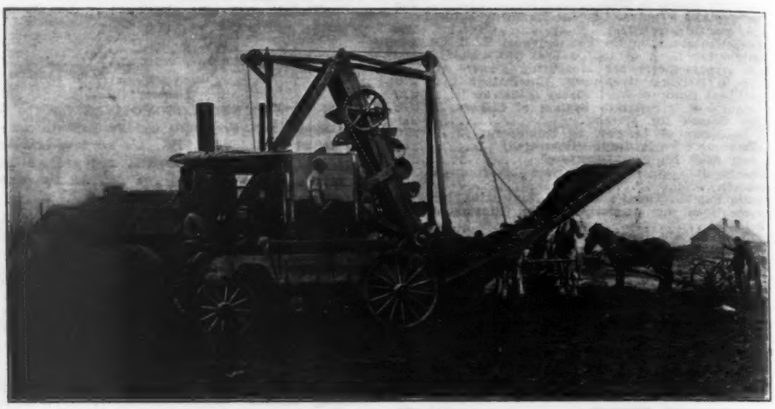
With the large tips the pressure was much reduced, owing to the long lengths of small pipe leading from the street main to the laboratory. To obtain greater pressure, a 2½-in. fire hose, attached to the hydrant near the building, was brought inside, fastened to a short length of 2-in. pipe, and then a connection made to the tip. In these latter experiments the gage was located 1 ft. above the tip.

The quantity of water discharged was measured by weight in every case. From the smaller nozzles it was collected in a tank holding a fraction over 1 cu. ft., and weighed on standard scales. The water from the larger nozzle was collected in a copper-lined tank holding about 8 cu. ft. This tank was provided with a weir at one end, and by watching the meniscus at the weir, the point at which the tank was exactly full could be found with much accuracy.

The order of procedure was as follows: The water was turned on and allowed to run to waste from the nozzle through a length of 3-in. tin leader pipe, until the flow became regular, and then at a word from a timekeeper the water was directed into the tank until the latter was nearly filled, then at the word, again allowed to run to waste. The additional amount of water required to fill the tank was then weighed, and the discharge obtained by subtracting this amount from the total contents.

It was not intended in the experiments to get the efficiency of each nozzle with any great degree of accuracy, but simply to compare in a general way the merits of the different forms. Some of these forms and connections are shown in the accompanying cuts. The dimensions of the orifices were obtained with calipers reading to 1,000 in.

Throughout the day the great use of water along the main caused fluctuations in the pressure which an automatic registering gage showed to be as much as 10 or 15 lbs., so that there would have been some uncertainty in the observed pressure, even had a mercury gage been used. Many experiments were made in the evening when the pressure became more constant, and gave a means of checking those made during the day.



A MACHINE FOR AUTOMATICALLY LOADING WAGONS BY SCRAPERS.
Designed by R. C. Ruthven.

The time of the experiment was taken to the nearest second, and the weight of water discharged could be measured within 2 lbs. It should be stated, however, that the results obtained for the larger nozzles are probably not as accurate as for the smaller ones, owing to the small size of the measuring tank used.

The temperature of the water averaged 40° F. at the time of the experiments. The weight given by Trautwine for this temperature is 62.425 lbs. per cu. ft. As 62.5 lbs. per cu. ft. is the basis of all hydraulic formulas, it was used in the computations. The difference would not be appreciable in the results.

By reducing the observed pressure to feet, giving the pressure head and adding to it the velocity head and the correction for the position of the pressure gage, the equivalent total or static head was found. Finally the theoretical velocity (or $\sqrt{2gh} \times$ area of orifice) gives the theoretical discharge, and the ratio of the actual discharge to this gives the coefficient of discharge, or efficiency.

The arrangement shown in Fig. 9 was made for the purpose of studying the effect of the sudden contractions and sharp edges presented by the common "bushings." It was made in two parts—the "tip" and the "bushing"—and as nearly as possible a cone. The diameter of the "bushing" was made 1-32 in. smaller than that of the "tip" at their junction, as shown, so that there would be no sharp edge presented to the stream by the possible poor workmanship. The end of the tip for ½ in. is cylindrical and the edge is carefully smoothed. When in use the "bushing" was screwed close up to the end of the pipe, so that there was a smooth conical passage from the pipe to the end of the tip.

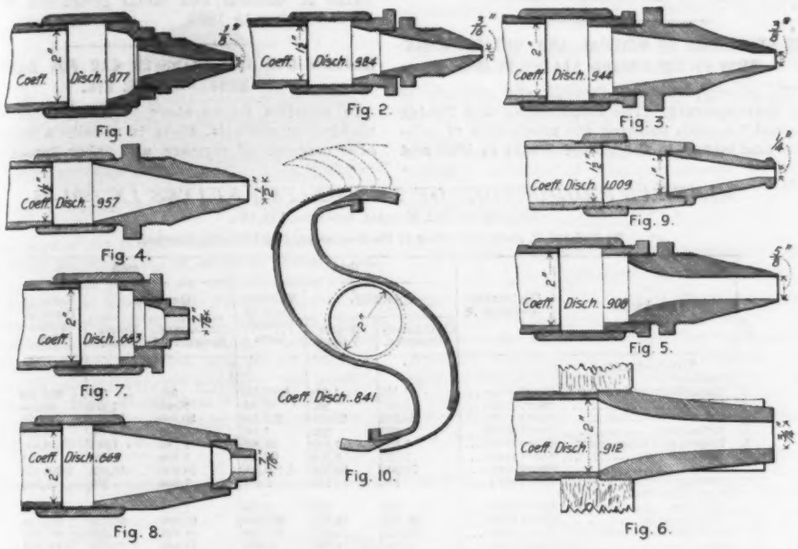
Figs. 7 and 8 show the tip from a water motor that is used quite extensively in this vicinity. It is a common gas plug with a 7-16-in. hole drilled in it. In the experiments two of the tips were used, alike in every respect, except that the bore of one was 1-16 in. out of center, and the experiments made with this eccentric tip are indicated in the table by a star (*). For some unknown reason this gives an efficiency considerably larger than the other.

Fig. 10 shows a bronze "water chute," which is

*Graduating Thesis Awarded First Honorable Mention in Engineering News Thesis Competition for 1895. The tabular statements of the experiments are briefly summarised in the table given herewith, and the cuts represent a selection of the different forms of nozzles tested.

arranged to direct two jets to the motor at the two ends of the diameter, the receiving buckets being shown by the dotted lines. The water is admitted at the center through a 2-in. pipe, whose axis is at right angles to the plane of the paper.

The orifices at each end are rectangular ¾ × ¼ in., and the openings varied from 0.33 to 0.25 in. These openings can be partially or wholly closed by a wedge, whose office is twofold; first, to direct the water outward against the buckets of the motor, and second, to regulate the size of the opening by moving it out or in. These wedges are attached to a gearing and the movement controlled by a handle outside the wheel.



VARIOUS FORMS OF NOZZLES FOR SMALL WATER MOTORS.

Conclusions.

As expected from the results of recent experiments with nozzles for fire streams, the conical tips give the highest efficiency. The cast-iron tips, Fig. 2, are conical, with only a short cylindrical portion at the end. Those shown in Fig. 4 are also conical, but the angle at the vertex is too large and the cylindrical part begins too far back, so that there is probably a slight contraction formed in the cylindrical part by the sharpness of the conical angle.

The high efficiency given by the experiments (in some cases more than unity), is probably due to a slight error in the graduation of the pressure gage. This error, however, can be but slight, for it is known to register correctly at about 80 lbs., since it agrees with the static pressure at 83 lbs. It is shown, however, that the efficiency of the conical tips at 70 lbs. is about 1½% greater than at 80 lbs., while at other pressures it seems to remain constant. Hence in all cases the efficiency obtained with the pressure at about 70 lbs. is probably 1½% too large. However, it was not intended, nor was it possible to reach this degree of accuracy with the apparatus available, so there has been no attempt in the experiments to make this correction. It simply shows that this conical tip has an efficiency very near to unity, as is also the case with the 3-16-in. and ¼-in. cast-iron tips. Therefore, it is concluded that the tip for a water motor should be, when possible, a cone. The angle at the vertex should be about 20°, and for a distance of about twice the diameter of the orifice from the end it should be cylindrical, and all sharp edges where the velocity is high should be avoided.

The form of the connection plays a very unimportant part in the results, and the effect of turning and smoothing the surface of the bushings is also not appreciable. In fact, the form or character of the surface of the water passage where the velocity is comparatively small, as it is in the larger parts of the passage, seems to be of no importance. But the effect of any sudden change at the end where the velocity is at its highest is seen by the results from the tip shown in Fig. 8.

With the conical tips the efficiency seems to be constant at all pressures. In tip Fig. 4, for example, the efficiency at 78 lbs. pressure is about the same as at 28 lbs. With the tips like Fig. 6, where the rate of contraction decreases from the pipe to the orifice, the efficiency is greater for high pressures than for low pressures. In cases where the rate of contraction increases at the orifice, as in Fig. 3, or there is a sudden contraction, as in Fig. 8, the efficiency is less for high pressures than for low.

Results of Tests of Nozzles for Water Motors.

Fig. No.	Tip. Dia., ins.	Tip. Mat.	Press. observ'd, lbs.	Time of flow, mins	Discharge. Lbs. per min.	Discharge. Cu. ft. per min.	Vel. in pipe.	Vel. head.	Position of gage.	Press. head.	Total head.	Theor. vel.	Theor. discharge.	Coeff. of efflux.
1....	½	c.-iron.	84	2	31.3	0.50	.38	....	−0.5	193.5	193.0	111.5	*.57	.877
2....	3-16	"	81	1	77.7	1.24	1.68	.04	....	186.6	186.6	109.6	1.26	.984
.....	¼	"	73	½	128	2.05	1.57	.04	−0.5	168.2	167.7	103.9	2.12	.967
3....	⅜	"	80	1.53	294	4.70	3.60	.20	+1.0	184.5	185.7	109.4	5.00	.940
3....	⅜	"	49	2.00	239	3.82	2 96	.13	−0.5	112.7	112.3	85.0	3.9	.979
4....	½	"	28.5	1.50	320	5.12	6.95	.75	....	65.6	66.3	65.4	5.35	.957
5....	⅝	"	16	1.40	345	5.52	4.22	.28	−0.5	36.9	36.7	47.6	6.22	.887
5....	⅝	"	75	.58	794	12.7	9.70	1.46	+1.0	173.0	175.5	106.3	13.6	.934
6....	¾	"	10	1.33	358	5.7	4.35	.29	−0.5	23.0	22.8	38.3	7.0	.813
6....	¾	"	70	.33	1176	18.6	14.20	3.15	+1.0	161.4	165.1	103.2	19.0	.979
7....	7-16	"	50	2.60	220	3.5	2.7	.11	+1.0	115.2	116.3	86.5	5.4	.648
7....	"	"	81	1.50	281	4.5	3.4	.18	+1.0	186.6	187.8	110.0	6.9	.652
8....	"	"	80°	2.00	241	3.8	2.9	.13	+1.0	115.2	116.3	86.5	5.4	.704
8....	"	"	81°	1.50	305	4.9	3.7	.21	+1.0	186.6	187.8	110.0	6.9	.710
9....	¼	brass.	70	3.50	131.1	2.10	2.75	.13	....	161.3	161.4	102.0	2.09	1.005
10....	.03	chute.	50	.75	....	1.42	1.1	.02	+1.0	115.2	116.3	86.5	1.62	.877
"	.1	"	50	1.67	....	4.48	3.4	.18	+1.0	115.2	116.4	86.6	5.41	.828
"	.1	"	79	1.25	....	5.82	4.4	.30	+1.0	182.0	183.3	107.6	6.79	.861
"	.25	"	50	.75	....	10.16	7.8	.94	+1.0	115.2	117.1	86.8	13.02	.780
"	.25	"	74	.57	....	12.61	11.4	2.00	+1.0	170.5	173.5	105.7	15 86	.795

THE CLAIMS OF THE CONTRACTORS FOR THE NEW CROTON AQUEDUCT.

In a very long personal letter to one of the editors of this journal, Mr. D. D. McBean, one of the contractors on the new Croton aqueduct, criticises the remarks made in our issue of April 9 concerning the proposed reference to a legislative commission of the dispute between the contractors and the city. Mr. McBean says that these remarks are based upon false representations as to the ground of the contractors' claims, as published in the newspapers, and he complains that the daily press has persistently declined to fairly present the claims made or to correct glaring misstatements as to the real nature of the contention of the contractors.

Though Mr. McBean does not ask us to do so, we present these claims below, as formulated by him, and leave our readers to judge for themselves as to the equities of the case:

In the first place there is a general public impression that the contractors are trying to get payment for the work done in making good their own defective work. This, says Mr. McBean, is wholly incorrect. What the contractors claim is that the amount of tunnel excavation for which they should be paid is the section originally fixed by the Aqueduct Commission and its Chief Engineer, and on which the monthly estimates were based, and not the smaller section which was substituted in place of the first when the commission was reorganized and on which the quantities of tunnel excavation were finally computed.

Mr. McBean further says that the Chief Engineer should alone decide whenever a difference of opinion exists regarding the reading of specifications, but the representatives of the city ruled differently. In spite of the clause in the contract providing that "the Chief Engineer shall in all cases determine the amount or quantity of the several kinds of work which are to be paid for under this contract," the counsel to the corporation ruled that it was his interpretation of the contract which was to control the Engineer. As a result of this ruling, the final estimate was made up by the Engineer in accordance with the interpretation of the counsel to the corporation, though this was contradictory to the original interpretation of the Engineer.

The story of how the original tunnel cross-section was fixed, and how it was afterward reduced, according to Mr. McBean, is as follows: Early in the history of the work a special committee of three was appointed to confer with Hon. Morgan J. O'Brien, Counsel for the Corporation, and Mr. Edward V. Loew, Comptroller, "to consider the claims and views of the said contractors" regarding the area of excavation to be allowed. After a full examination and with the consent of the counsel and Comptroller, the following resolution was adopted:

> Resolved, That the cross-section of tunnel excavation (except timber section) should be the area of the conduit plus that of the masonry around the conduit necessary to preserve the shape of the conduit against the pressure of the surrounding medium; allowance to be made for the necessary weepers and other contrivances specially mentioned in the contracts; and that the Chief Engineer and the Consulting Engineer will report whether the method of calculation adopted to this time conforms to the principle above enunciated and that they present an average typical cross-section, or cross-sections, showing what allowances should be made, embracing in said cross-sections the area of the conduit, the necessary masonry, necessary weepers and other contrivances as above specified.

In accordance with this resolution the Chief and Consulting Engineers reported that—"We find that the methods of calculation adopted to this time conform to the principle enunciated in the resolution." They also submitted an average typical cross-section, showing a general thickness of 20 ins. of masonry around the inside area of the conduit.

Corporation Counsel Morgan J. O'Brien, now Judge of the Supreme Court, certified to the Comptroller that the resolution referred to was in accordance with the terms of the contract, and on this basis all approximate estimates were made out up to the time of the completion of the tunnel excavation.

Later, and at a time when it was popular to denounce the aqueduct contractors, says Mr. McBean, a change of city officers occurred and new Aqueduct Commissioners were appointed. Whatever may have been the cause, says our correspondent, a change of policy was at once ap-

parent towards the contractors. A report was framed and adopted, which in effect reduced the allowance for tunnel excavation from 20 ins. outside the conduit area to 12 ins. outside this area. The late Gen. John Newton, then a member of the commission, was absent at the time this resolution was adopted; but on his return he vigorously objected to the conclusions arrived at, on the ground that gross injustice had been done to the former commission, and that no one before "had dared to deny the soundness of the interpretation which the former commission, and the Corporation Counsels have placed upon the provisions of the contract in relation to tunnel excavation." Gen. Newton refused to further act with this commission.

The old Chief Engineer was then removed, and his successor, under the orders of the commission and the counsel for the corporation, in making up the final estimates, allowed only the 12 ins. outside the conduit area, instead of the 20 ins., certified to by himself, as former Consulting Engineer, as being the allowance called for by the contract under the resolution of the old commission.

Mr. McBean and his associates now claim that an injustice is done them in this arbitrary reduction of the cross-section area on which payment is based. They cannot sue the city of New York in any court outside that city, and they must go to such court as the city selects. In the case already tried, the Judge did not let the case go to the jury. But the Judge, in one part of his opinion, unconsciously admitted the contractors' claim, when he said that:

"As the work progressed the Engineer was to determine how much of an excavation was required for the construction of the aqueduct at each particular place." . . . "and when such a cross-section was established the contractor was bound to excavate up to that line. He was, however, to be paid only for the excavation within the line as given him by the Engineer."

But the Judge further ruled that—

When the Engineer was required to give his final certificate this question, as to the amount of excavation for which the plaintiffs were entitled to be paid, was presented to him for his determination. . . . It was, therefore, at the time of making the final certificate that these questions had to be met and finally dertermined."

The contractors claim that under the first ruling the cross-section was fixed at 20 ins. "as the work progressed," and that they should receive pay for that amount. But the second ruling requires them to abide by the cross-section as established at the time of making the final estimate. The Court of Appeal's Judge, in interpreting the plans and specifications, says that while the cross-sections show the tunnel lining of brickwork to range from 12 ins. to 16 ins., and even more, in thickness, they all leave the inside area of the tunnel as equal to the requisite size of 201 sq. ft. He further says:

"By the final certificate the plaintiffs have been allowed at all times at least as much excavation as was limited by the exterior lines of the brickwork surrounding the tunnel at any particular point."

He says also that the cross-section should be determined by the Engineer with reference "to the exterior line of the brickwork lining the tunnel."

Clause 17F of the contract says: "The form and area of the cross-sections of the tunnel excavation at any place shall be such as the Engineer may determine for that place, but at all points it shall have an area of at least 201 sq. ft." The Judge referred to interprets this as meaning that the free inside area of the conduit shall be not less than 201 sq. ft., and in calculating tunnel excavation he practically adds to this the thickness of the brickwork. But Corporation Counsel Beekman ruled that the 201 sq. ft. meant the cross-section of the area of excavation to be paid for, and in the final estimate a cross-sectional area of 204 sq. ft. was allowed. This the contractors claim is not enough; on the assumption of 201 sq. ft. for inside area plus the area of 12 ins. of brickwork all around, instead of 20 ins., the contractors will accept payment in full. But, says Mr. McBean, the fact is that the inside space of the tunnel surrounded by brickwork has at no place on the new Croton aqueduct an area of 201 sq. ft., though the opinion of the Judge of the Court of Appeals is that this is what was meant by the contract.

The contractors further claim that in the original plans for the aqueduct weepers were provided to admit groundwater into the tunnel, with a view of adding to the supply. About the time of the completion of the work the fact was developed that this seepage water was contaminated. The contractors were required to shut it off, and were promised payment therefor. They performed this work, but now claim that payment was denied, and when they applied to the courts, they were met by a statute law exempting the city of New York from a common law liability. We have discussed the points raised by Mr. McBean's letter in our editorial columns.

THE STATISTICS OF MINERAL AND METAL PRODUCTION IN THE UNITED STATES IN 1895.

We present herewith through the courtesy of our contemporary, "The Engineering and Mining Journal," a table showing the production of minerals and metals in the United States in 1894 and 1895. The statistics here summarized were collected for our contemporary's annual publication, "The Mineral Industry," the fourth annual issue of which is now in an advanced stage of preparation.

It will be seen that the total value of mineral and metal production in 1895 exceeded the value of 1894 by over $95,000,000. Attention is called to the fact, however, that some quantities appear twice in the table; hence some deductions should be made from the record of totals given. Thus, the coal used in making coke, and the iron ore used in making pig iron should be deducted to arrive at the correct total. Making deductions for all duplications of this class, the compiler of these statistics reaches $628,689,505 as the actual total value of mineral and metal production in the United States in 1895.

MINERAL PRODUCTION OF THE UNITED STATES IN 1894–95.

Compiled for THE MINERAL INDUSTRY, Vol. IV.,

By Richard P. Rothwell, editor of the *Engineering and Mining Journal.*

No.	Products.	Customary Measures.	1894. Quantity. Customary Measures.	1894. Quantity. Metric Tons.	1894. Value at Place of Production.	1895. Quantity. Customary Measures.	1895. Quantity. Metric Tons.	1895. Value at Place of Production.
	NON-METALLIC.							
	Abrasives—							
1	Corundum and emery	Short tons	1,120	1,106	$109,500	385	349	$56,400
2	Garnet	Short tons	1,000	907	35,000	2,065	1,873	93,350
3	Grindstones	Short tons	29,989	27,200	257,598	86,380	83,004	290,378
4	Millstones	Short tons	397	360	4,447	105	95	8,525
5	Tripoli and infus. earth	Short tons	1,663	1,508	22,885	1,788	1,622	26,049
6	Whetstones	Short tons	1,735	1,574	84,450	1,600	1,450	78,303
7	Alum	Short tons	72,000	65,304	2,160,000	75,000	68,025	2,225,000
8	Antimony ore	Short tons	165	150	9,075	1,083	982	37,905
	Asbestos and talc—							
9	Asbestos	Short tons	265	240	4,350	1,010	916	11,400
10	Fibrous talc	Short tons	50,500	45,804	505,000	66,500	60,316	665,000
11	Talc and soapstone	Short tons	21,044	19,087	401,892	18,885	17,129	361,353
12	Asphalt	Short tons	4,198	4,080	75,654	14,300	12,970	300,000
13	Bituminous rock	Short tons	54,199	31,018	148,120	43,778	39,707	143,456
14	Barytes	Short tons	23,758	21,548	95,032	20,255	18,371	99,030
15	Bauxite	Long tons	10,732	10,906	42,928	14,145	14,371	56,580
16	Borax	Pounds	13,140,584	5,962	919,841	13,506,356	6,126	742,850
17	Bromine	Pounds	379,444	172	98,655	394,854	179	102,662
18	Cement, natural hydraulic	Bbls., 300 lbs.	7,813,766	1,064,297	4,455,928	7,694,053	1,047,006	4,597,285
19	Cement, Portland	Bbls., 400 lbs.	611,229	110,877	1,209,446	749,059	135,879	1,430,089
20	Clay, refractory	Short tons	3,375,798	3,061,794	4,050,885	63,750,000	3,401,250	4,500,000
21	Clay, kaolin	Short tons	24,552	22,246	185,169	30,910	28,035	258,431
22	Coal, anthracite	Short tons	a52,010,433	47,183,345	80,879,404	a58,362,985	52,965,538	89,948,699
23	Coal, bituminous	Short tons	a117,865,348	106,903,871	103,758,967	a138,079,466	125,247,053	125,489,488
24	Coke	Short tons	8,495,295	7,706,846	12,654,558	9,927,348	9,006,090	15,258,935
25	Cobalt oxide	Pounds	6,550	3	8,843	6,400	3	8,640
26	Copperas	Short tons	14,907	13,511	104,160	14,118	12,805	69,846
27	Copper sulphate	Pounds	b60,000,000	27,215	2,016,000	45,000,000	20,412	1,350,000
28	Chrome ore	Long tons	2,653	2,607	35,125			
29	Feldspar	Long tons	18,704	19,008	83,465	22,195	22,550	104,082
30	Fluorspar	Short tons	6,400	5,805	58,304	4,000	3,628	36,440
31	Graphite	Pounds	770,846	349	34,089	392,008	178	17,640
32	Graphite, amorphous	Short tons	165	150	1,252	1,100	998	4,700
33	Gypsum	Short tons	301,536	273,498	910,831	298,572	270,804	974,219
34	Iron ore	Long tons	11,880,000	12,070,080	20,790,000	16,950,000	17,221,200	29,662,500
35	Lime	Bbls., 200 lbs.	b66,750,000	5,148,320	28,375,000	b60,000,000	5,443,164	30,000,000
36	Magnesite	Short tons	1,370	1,243	7,864	2,200	1,995	14,700
37	Manganese ore	Long tons	11,735	11,924	74,860	14,885	15,121	92,044
38	Mica, ground	Pounds	829,500	377	35,957	750,000	340	31,956
39	Mica, sheet	Pounds	9,000	4	11,108	6,200	3	6,400
40	Mineral wool	Pounds	5,776	5,239	58,936	6,742	6,115	69,481
41	Monazite	Pounds	750,000	340	45,000	1,000,000	862	114,000
42	Natural gas				13,000,000			12,000,000
43	Paints, mineral	Short tons	47,593	43,167	1,011,182	47,084	42,705	1,086,767
44	Paints, vermilion	Short tons	91	83	111,309	118	107	118,190
45	Paints, white lead	Short tons	87,342	78,155	8,445,174	92,000	83,462	8,740,000
46	Paints, zinc oxide	Short tons	22,814	20,697	1,711,275	22,600	20,498	1,588,300
47	Petroleum (crude)	Bbls., 42 gals.	48,527,336	6,158,119	40,762,962	50,652,025	6,430,742	42,547,701
48	Phosphate rock	Long tons	952,155	967,485	2,856,465	831,498	844,802	2,577,643
49	Marls	Long tons	225,000	228,622	607,500	217,700	221,183	587,790
50	Precious stones				150,000			150,000
51	Pyrites	Long tons	107,462	109,182	466,466	81,000	82,296	353,560
52	Salt, evaporated	Bbls., 280 lbs.	11,708,650	1,498,193	5,586,326	12,521,498	1,539,178	5,844,348
53	Salt, rock	Bbls., 280 lbs.	2,341,922	297,376	784,063	1,367,638	173,662	518,740
54	Silica, sand and quartz	Long tons	477,670	485,313	418,612	523,640	532,018	553,128
55	Slate, roofing	Squares	611,776	180,474	2,007,321	645,361	190,277	2,062,239
56	Slate, other manufactures	Square feet	4,395,125	12,966	399,758	3,786,599	11,170	369,062
57	Stone, limestone (flux)	Long tons	3,544,396	3,601,459	2,126,636	3,390,000	3,444,240	2,542,500
58	Stone, marble	Cubic feet	6,331,279	518,532	3,576,853	6,942,533	568,593	4,086,361
59	Stone, onyx	Cubic feet	1,450	110	29,000	800	66	10,750
60	Sulphur	Long tons	441	488	7,056	12,000	12,192	192,000
61	Other building stones				b30,000,000			33,000,000
	Total non-metals				378,877,939			428,266,385
	METALS.							
62	Aluminum	Pounds	817,600	371	490,560	900,000	408	495,000
63	Antimony	Short tons	220	205	39,200	433	393	68,847
64	Copper	Pounds	353,504,314	160,392	33,540,489	386,453,850	175,294	36,944,988
65	Gold	Troy ounces	1,923,619	c59,824	39,761,205	2,265,612	c70,470	46,830,200
66	Iron, pig	Long tons	6,657,388	6,764,572	71,966,364	9,446,308	9,597,449	108,632,542
67	Lead, value at New York	Short tons	160,867	145,906	10,585,048	156,854	142,298	10,132,768
68	Quicksilver	Flasks, 76½ lbs	30,440	1,056	1,095,840	33,978	1,179	1,313,589
69	Silver, commercial value	Troy ounces	49,846,875	c1,550,387	31,403,531	46,331,235	c1,441,087	30,254,206
70	Zinc spelter	Short tons	74,004	67,135	5,309,882	81,858	74,245	5,942,890
	Total metals				194,092,119			240,615,120
	Est. products unspecified				5,500,000			5,000,000
	Grand total				578,470,058			673,881,505

(a) Bituminous coal includes brown coal and lignite. The anthracite production is the total for Pennsylvania, Arkansas, and Colorado. (b) Estimated. (c) Kilograms.

BARROW CAR AND TRANSFER CAR FOR HANDLING BROKEN STONE, ETC.

In quarries where stone is got out for road-making or concrete, there is usually a considerable amount of expense and labor involved in the handling of the broken rock between the face of the work and the crushing plant or cars. We illustrate herewith a barrow car designed for facilitating this work. It consists of an iron tray having a large wheel in the center and a small guide or steadying wheel on each side. The large

wheel is enclosed in a hood and runs on a single 8-lb. T-rail, while the guide wheels run on rough timber longitudinals. The car is moved as a barrow by two handles, and the top of the hood is fitted with a loop to which the hook of a derrick or crane rope can be attached for hoisting. Fig. 1 is a view of the car and Fig. 2 shows it in use at a quarry, loaded with 3,140 lbs. of stone.

Fig. 1.—Barrow Car for Handling Stone, Etc.

This barrow car is manufactured by the American Road Machine Co., of Kennett Square, Pa., and is intended for use in railway excavations, mines, quarries, brick yards, gas works, etc., and for handling coal in factories, hotels, etc. Some of the testimonials state that one man can wheel a load of 2,500 to 3,500 lbs. in a car on the level, and at one quarry the cost for labor has been reduced from $6 to $1 per day, while the saving in cost of handling broken stone for road work is said to be only 10 cts. per cu. yd.

FIG. 2.—BARROW CAR IN USE AT A QUARRY.

Another expensive item in the cost of handling stone for road work is the shoveling from railway cars into wagons, and Fig. 3 represents in diagram an apparatus designed by Gen. Roy Stone, Engineer of the Road Enquiry Office, U. S. Department of Agriculture, to reduce this cost and facilitate the work. This apparatus has been adopted by the California Highway Commission and will form part of the state plant for furnishing road material to counties. It consists of a series of bins or tubs, 3½ × 4 ft. and 3 ft. long,

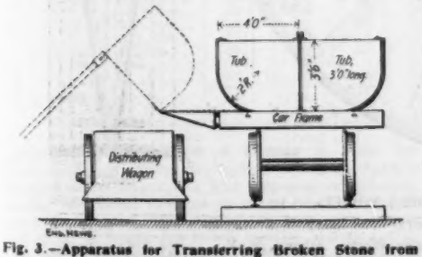


Fig. 3.—Apparatus for Transferring Broken Stone from Railway Cars to Wagons.

mounted on a car frame, and having the outer side curved to a radius of 2 ft. The bins are linked together at the back during transportation, and when unlocked are tilted over by a lever fitted on the pin of the tub onto portable skids hooked to the car, thus dumping the contents into the wagon drawn up at the side of the car. An iron strap has one end bolted to the car frame and the other end hinged to the outer corner of the tub. This holds the tubs in position during transportation, and also prevents them from being thrown off the car while being dumped. The wagon shown is the distributing wagon with spreading tail door, which was illustrated in our issue of March 14, 1895. The following note on the cost of shoveling stone is taken from the Massachusetts Highway Commission's report for 1893:

In reply to the question as to the cost of shoveling broken stone onto carts, 25 towns answered: "This cost varies from 4 to 20 cts., a mean of about 9½ cts. per ton." In this connection it is well to call attention to the fact that an elevator and bins, or bins set up to load without shoveling, will save 9½ cts. on each ton of stone on this one item. If the time saved on the team while waiting to be loaded be taken into account, the saving may be estimated to be from 20 to 30 cts. a ton, or about $500 on 2,000 tons of stone.

THE SEMI-CENTENNIAL OF THE PENNSYLVANIA RAILROAD CO.

At the celebration, on April 13, of the fiftieth anniversary of the Pennsylvania R. R. Co., President George B. Roberts sketched the progress made by the company in its half century of existence. While the company was organized in 1846, it was not until 1852 that it possessed a line of transport between Philadelphia and Pittsburg, and then only in connection with the State works. In 1852 the company operated 224 miles of railway, its capital stock and debt was $12,000,000. In the first year of its operation it carried about 70,000 tons of freight and about 500,000 passengers.

In contrast to this the company now owns 357 miles of railway between Philadelphia and Pittsburg; it owns or controls what were once 256 corporations, now merged into 138 distinct companies; and it controls 9,000 miles of railway, with an aggregate capital of $834,000,000. As compared with the 70,000 tons of freight of 1852, in 1895 the entire system moved 160,000,000 tons of freight, and it carried with reasonable safety and precision 75,000,000 of passengers. In 1852 the company owned 50 locomotives and not over 1,000 cars of all kinds. To-day 3,400 locomotives and 141,000 cars of all kinds are in use on the company's system, and 226 barges, steamboats and other craft are used on the water in connection with its lines.

The gross income of the corporation, in 1852, was less than $2,000,000; in 1895, the gross income from the entire system was over $133,000,000. In 1852 its pay roll amounted to less than $400,000; in 1895, this had grown to over $36,000,000, or an average of more than $100,000 per day, which is distributed among 97,000 employes. After paying all its debts the corporation has distributed to shareholders, in these 50 years, over $166,000,000.

But, as Mr. Roberts pointed out, in this same 50 years, the population of the United States grew from less than 25,000,000 to nearly 70,000,000; and the population of Pennsylvania increased from 2,500,000 to 5,700,000. The City of Philadelphia, in 1852, numbered less than half a million, and Pittsburg contained less than 40,000 inhabitants. To-day Philadelphia has nearly 1,200,000 inhabitants and Pittsburg 280,000. In 1852, there were only 10,900 miles of railway in the entire United States, as compared with 179,279 miles, on Jan. 1, 1895. In 1840 the State of Pennsylvania had an aggregate of 953 miles of railway; on Jan. 1 last, the aggregate for that State alone was 9,511 miles.

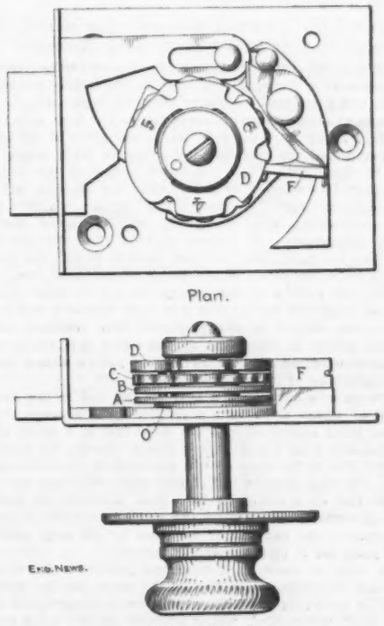
From another sketch presented at the time, it appears that this company has only had five presidents in its 50 years of existence. When organized on April 13, 1846, Samuel Vaughan Merrick, who was one of the most active promoters of the enterprise, was made the first President. After serving three years he was succeeded by Mr. Wm. C. Patterson, also one of the original organizers of the road. Three years later Mr. Patterson was followed by J. Edgar Thomson, the former Chief Engineer of the road, and Mr. Thomson held that office from Feb. 2, 1852, until his death in 1874. He was followed by Thomas A. Scott, who was in turn succeeded, 15 years ago, by George B. Roberts, the present President.

A COMBINATION LOCK WITHOUT A DIAL.

A combination lock, in which no dial is used, and which is operated by the senses of hearing or feeling only, has recently been placed on the market. As a lock it is applicable to doors, drawers or lockers, and is durable, cheap and simple in construction.

The lock mechanism essentially consists of a corrugated tumbler, C, upper and lower lock-disks, D and E, working in combination with a pawl, F. Two other disks, B and A, and a washer, O, are used in changing the combination, which may be varied 350 times for any one lock, according to full directions sent out by the makers.

Unlocking is prevented by the normal position of the projection on the lower disk, E, touching a corresponding projection on the bolt itself. On the disk, D, is a so-called "smooth place," which lifts the pawl out of the corrugations. Starting with the pawl thus lifted, a specified number of



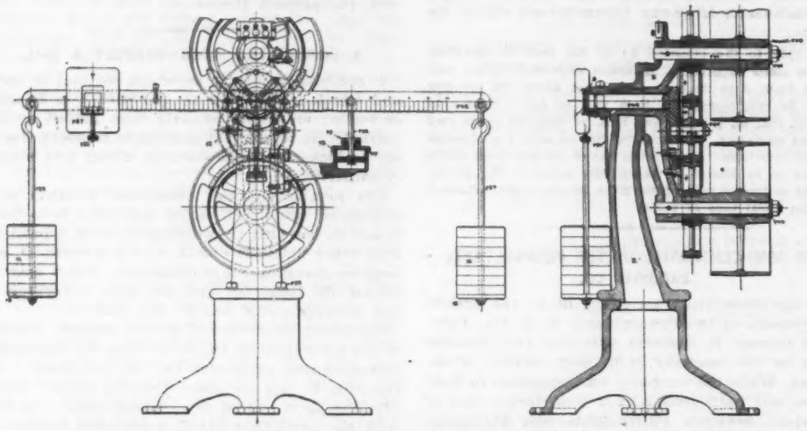
A Combination Lock Without a Dial.

turns of the knob are made, to the right, to the left, to the right again, and finally a turn which revolves the lower disk, E, and withdraws the bolt. While the clicks of the pawl in the corrugations may be heard and counted, the pulsations made by this movement may be also felt and counted. As a consequence the lock can be readily opened in the dark. It is practicably unpickable. These locks are already extensively used in the West for school and gymnasium lockers. The lock is made by the Keyless Lock Co., 180 Lake St., Chicago, Ill.

THE SUN'S ECLIPSE IN AUGUST will be observed from the Island of Yesso, Japan, by an American scientific party now on its way to that country. This party is made up of Prof. Todd, of Amherst College; Prof. Garrish, of Harvard Observatory; Lieut. Pemberton, of the U. S. Navy; Mr. Thompson, in charge of the mechanical department of the Amherst corps; Dr. Van de Pool Adriance and Arthur M. Francis. This party is being conveyed to its destination by the yacht "Coronet," belonging to Mr. Arthur C. James, of the firm of Phelps, Dodge & Co., of New York. Mr. James and his wife accompany the expedition.

A NEW DYNAMOMETER FOR MEASURING POWER ABSORBED IN DRIVING MACHINERY.

We illustrate herewith a new transmission dynamometer, constructed by the Riehle Testing Machine Co., of Philadelphia. It is an improvement on an instrument built by Prof. S. W. Robinson, of the Ohio State University, Columbus, O., for use in the Mechanical Laboratory of that institution. We condense the following description from a circular issued by the manufacturers:



THE RIEHLE-ROBINSON DYNAMOMETER FOR MEASURING POWER TRANSMITTED.

This machine consists essentially of a supporting frame, or pedestal, a T-shaped arm carrying the driving mechanism, and a graduated scale or weighing apparatus.

In use the instrument is made fast to the floor with the pulleys under or to one side, but in the plane of the belt which drives the machine, the power to drive which is to be measured. Then the lower pulley of the dynamometer is connected by a belt with the machine, while a second belt connects the upper pulley on the instrument with the pulley on the power shaft. This arrangement of pulleys enables the observer to connect his instrument without moving either the machine to be measured, or the driver on the main line.

The two pulleys of the instrument are mounted on a strong cross-tree bar so that they both overhang and can be swung around to any position. This overhang and swing makes it convenient to put either belt on or off without unlacing, and to swing the puleys either way for tightening or loosening both belts

The pulleys have each a gear on the end of the hub, both of which mesh into a smaller gear between, the latter being supported on a pin made fast as a crank pin in the arm from a shaft which passes through the center of the hub of the cross-tree in the head of the main column. To the opposite end of this shaft the poise bar is made fast by a set screw in a boss to which the poise bar is secured. Thus when the small intermediate gear is thrust to the one side or the other by the large gears, the poise bar is correspondingly moved.

As work is transmitted from one pulley to the other through the intermediate gear on the crank pin, the latter will be thrust to one side with a force proportioned to the effort transmitted, which tends to tip the poise bar, to prevent which weights are applied. The equilibrating weight, together with the speed, etc., furnish data for the calculation of the work being transmitted.

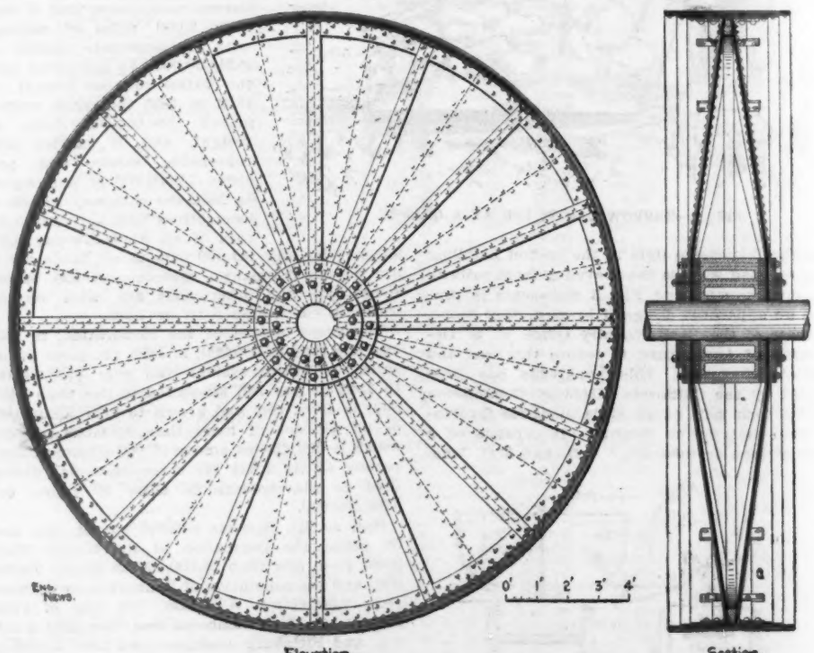
The poise bar is graduated and has a sliding weight, which moves from one end to the other, and the graduations count from 0 at the middle to 10 at either end. At each end of the bar is a knife-edge pin to which is suspended a rod and pan that may carry 14 or less weights of 5 lbs. each. Each weight is marked "5 lbs.=100 ft. lbs. per rev. as shifted from pan to pan."

In starting an experiment, the weights may be equally divided between the opposite ends of the poise bar, and the poise weight may be in the middle of the poise bar, when the latter is in equilibrium, or balanced. The poise weight is then moved out more and more on the poise bar till the end is reached if not sooner equipoised by the work being transmitted. Then the poise weight is brought back to the center, and one 5-lb. weight at the same time moved over from one poise pan to the other, the same making a difference of 10 lbs. and just equal to the 10 of the poise weight moved from end to center. Then the poise weight is moved out again, and so on, until finally an equilibrium is found as between the poise bar at one end and the gears at the other end of the crank shaft. Then a count of the weight will tell the number of pounds that acted to turn the poise bar. Each new instrument should be calibrated and have a correcting diagram made out for itself, as the law of each instrument may differ from that of another.

A FLY-WHEEL BUILT OF STEEL PLATES.

The accompanying drawing shows a steel plate belt-wheel, designed by Messrs. Thomas E. Murray, Consulting Engineer of the Albany Railway Co., and Harry E. Campbell, of the Albany Construction Works.

Two of these wheels were designed for two Cooper-Corliss tandem compound engines belonging to the Albany Ry. The cylinders are 20 and 36×48 ins., and the speed 72 revolutions per minute. One of these wheels is now running. It was constructed in such an accurate manner that it has not been found necessary to turn off the face, although it will be done later. Each of these engines is belted to a 500-K-W. General Electric generator run at 550 volts. The wheels are built of shell steel of 60,000 lbs. tensile strength. They are 20 ft. diameter, 50 in. face and weigh each 57,930 lbs., distributed as follows: Rim, 32,000 lbs.; disks, 16,400 lbs.; hub, 9,530 lbs. It is calculated that the wheels would stand safely a speed of 250 revolutions per minute, which is equivalent to a speed of rim of 13,708 ft., or nearly three miles per minute.



Elevation. Section.

STEEL PLATE BELT WHEEL.
Designed by Messrs. Thos. E. Murray and Harry E. Campbell.
Built by the Albany Construction Works, Albany, N. Y.

The hub is put on the shaft in five parts and is secured to the wheel proper with 32 1¼-in. steel bolts. The filler of the hub is of cast iron, and the hub is built up of 20 steel plates riveted together as shown.

The disks are each composed of two layers of ¼-in. plates, with joints broken, and 32 5×⅜-in. steel bars covering outside joints. These bars are also forged at the rim ends, so as to run parallel to the face of the wheel. A cast-iron filler ring connects the disks, through which the bolts pass, securing the 6×6×½-in. angle irons and disk plates. The rim plates and the 5×¾-in. bars are secured together with 64 1¼-in. rivets countersunk on the face. There are four thicknesses of plates in the rim besides the 6×6-in. angles, and they are all securely riveted together with joints broken. The work is being done at the Albany Construction Works.

MAINTENANCE OF A SEPARATE SYSTEM OF SEWERS.

Under the above title Mr. T. Harry Jones, City Engineer of Brantford, Ont., read a paper before the Ontario Land Surveyors at Toronto the latter part of February. The paper related to sewers in Brantford, where the system has been under the charge of Mr. Jones for the past three years. All work done during that period, both construction and maintenance, has been done by the city with day labor.

Brantford has a population given by Mr. Jones as 16,314. There are 2.1 miles of 15 to 24-in. main and 11.2 miles of 9 to 15-in. lateral sewers in use, with 497 house connections. The population now using the sewers is given at 3,000, with a yearly increase of 500.

There are 52 flush tanks in use, each set to discharge once a day, the capacity being 200 gallons each. Of the 52 flush tanks nine are Van Vranken and the remainder a compound of the Field siphon and Van Vranken tilting tank. The best results have been obtained from the Van Vranken. Monthly inspections are necessary to keep the flush tanks in order, it generally being necessary on each inspection to give air or regulate the water for two or three tanks. About three or four tanks a year require repairs, generally from the rusting and catching of the tilting tanks.

Regarding the flushing of the sewers, Mr. Jones writes as follows:

The flush-tanks are generally found sufficient to keep the 9-in. sewers clear, although it is occasionally found advisable to turn the water in the flush-tanks on to the full extent.

It has been found necessary to pass the plunger through

only two of the 9-in. sewers during the past three years, each of these sewers having been flushed once in this manner.

There are two of the 12-in. sewers which require flushing about once in every three months. In one of these the sewage backs up owing to a fungous growth becoming attached to the pipes. The other 12-in. sewer —known as the Clarence Street sewer—was constructed under great difficulties, being laid for a distance of 2,300 ft. in running sand, and at an average depth of 12 ft. below the ground and 5 ft. below the water level, and running parallel to, and about 15 ft. distant from a line of railway.

In addition to the fungous growth above mentioned, the leakage of sand into the pipes, has helped to cause this sewer to back up.

Excepting the 18-in. iron syphon under the canal, through which the plunger is passed twice during the year, none of the sewers above 12 ins. in diameter have yet required special treatment in this way.

Instead of using the ordinary copper or wooden spherical "pill" which has a diameter of 2 ins. less than that of the sewer to be flushed, we have found the following apparatus to be much more effective: It consists of a reel or plunger, formed of two rubber discs of the same diameter as the sewer to be flushed, cut from ¼-in. rubber belting. These are backed by wooden discs, from 1¼ to 1½ in. in thickness and from 2 to 3 ins. less in diameter than the sewer. These discs are strung about 8 ins. apart on a ½-in. iron rod, and are kept apart by a piece of gas pipe sliding on the rod, and are held in position by a collar near one end of the rod and a nut at the other end. The rod is provided with an eye at one end, and a swivel at the other end, for attaching the ropes, which are each some 25 ft. longer than the distance between the manholes.

In flushing a sewer the plunger is usually put through twice. The sewer is first flushed block by block, beginning with the lowest block on the sewer, and using the plunger suitable for a smaller pipe. Then the sewer is flushed straight through from the upper end, using the plunger which fits the pipe.

Beginning at the upper manhole of the block of sewer to the flushed, the leading rope is passed through the pipe to the manhole below. Then the plunger follows, and is taken through principally by the pressure of water backed up behind, the trailing rope serving to keep the plunger from going too fast, while the leading rope is serviceable if the plunger is inclined to stick. The usual method of passing the leading rope from manhole to manhole, by means of a float with a string attached, having been found to cause so much delay we adopted the following plan: Elm strips 2 ins. wide, ½ in. thick, and 12 ft. in length are bolted together end to end by two iron straps and four stove bolts to each joint, the straps being 1 × ⅛ × 6½ ins., and the bolts 1 × 3-16 in. These form practically one long slat which will reach from manhole to manhole, and will bend readily, and can be pushed down the manhole and through the sewer. To this the rope is attached.

These strips can easily be pushed 400 ft. through a 9-in. pipe, and 100 ft. through a 4-in. pipe, and are of great service in locating faults and stoppages. A gang of three men will flush about 700 ft. in a day.

House sewers are constructed from the street sewer to the property line by the city, nearly all of these being 4 ins. in diameter. Stoppages in house sewers generally occur at the junctions with the main sewers, which were formerly made with a bend, as a rule. On an average there have been about 15 stoppages per year, and the cost of removal has averaged about $4.25 each. When the householders are shown to be responsible for stoppages, as is true in the majority of cases, they are required to pay for their removal. Some of the items in the maintenance account for the past three years, after deducting the cost of stoppages paid by householders, are as follows:

	1893.	1894.	1895.
Stoppages in house sewers	$30	$25	$33
Flushing with the plunger	127	97	68
Repairs	128	130	144
General maintenance	225	223	224
Totals	510	475	469

About half of the expenditure for flushing and repairs was chargeable to the Clarence St. sewer, mentioned at the beginning of the above quotation. The rate of wages has been $1.60 a day for a "working foreman" and $1.25 a day for the men. The prices include nothing for engineering and inspection. It is not stated whether the water used for the flush tanks is included. At 200 gallons per day each tank would require 73,000 gallons a year, and the 52 tanks would require 3,796,000 gallons in that time.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Official Boundaries.

The official plat of a township showed that sections 23 and 26 are fractional, bordering on a river on the west; that a meander line runs through them, and that the area of certain lots in such sections is 170.42 acres. In fact, along such meander line is a bayou, west of which, between it and the river, is a body of land over a mile wide, containing 600 acres, which was never surveyed. The length of the section line between such sections, from the east line to the meander line, is given on such plat as 30.55 chains, while the distance from such east line to the main body of the river is about 1½ miles. It was held, that such bayou, and not the main body of the river, is the boundary of such sections and lots, and that a patent of such lots "containing 170.42 acres, according to the official plat," did not convey the land between the bayou and the main body of the river.

The rule of public surveys, as prescribed by chapter 9, tit. 32, Rev. St. (pages 458 and following), requires that they be surveyed into townships of six miles square with subsequent subdivisions into 36 sections of a mile square, except where the line of an Indian reservation or of tracts of land theretofore surveyed or patented, or the course of navigable rivers, renders this impracticable, with a proviso that "in case this rule must be departed from no further than such particular circumstances require." If this tract west of the bayou, and between it and the river, was intended to be surveyed, obviously all the lines of sections 23 and 26 would have been run along straight lines and so as to make complete sections and quarter sections. But such lines—at least those on the west side—were not run, and whatever the reason, the survey stopped at the water line of the bayou, and left this body of land west of it wholly unsurveyed. Although it was unsurveyed, it does not follow that a patent for the surveyed tracts adjoining carries with it the land which, perhaps, ought to have been, but which was not in fact surveyed. The patent conveys only the land which is surveyed, and, when it is clear from the plat and the surveys that the tract surveyed terminated at a particular body of water, the patent carries no land beyond it. Cases of this nature are naturally few in number. Lammers v. Nissen 4 Neb. 245, is somewhat in point. In that case it appeared that between the meander line, as run and the Missouri river, was a tract of several hundred acres; and the court held that, as that body of land had not been surveyed, it did not pass by a patent of a lot which, on the government plat, extended to the meander line.

A similar ruling was made in Glenn v. Jeffrey 39 N. W. 160. Whitney v. Lumber Co., 47 N. W. 425, was a case in which the meander line shown in government surveys was half a mile or more from the rest borders of a lake; and the court, in a very careful opinion, discusses the law of official surveys, and holds that as the meander line was a mistake the patent did not carry the land to the actual boundary of the lake, but only to the straight line which would have been the boundary of the quarter section if accurately surveyed. And the same doctrine is reaffirmed in Lally v. Rossman 51 N. W. 1132. But it is said that, because the water mentioned on the plat is called a river, the boundary must be taken as the water line of the river, and cannot be that of any intermediate bayou. In the case of Bates v. Railroad Co., 1 Black, 204, a patent had been granted for 102.29 acres lying north of the Chicago River, bounded by it on the south, and by Lake Michigan on the east. The contention was that the main channel of the river entered the lake much below the line shown on the plat, and so the patent carried a larger tract than that described therein. It appeared that there were two channels of the river, and the court said, in reference to this: "The mouth of the river, being found, establishes the southeast corner of the tract. The plat of the survey, and a call for the mouth of the river in the field notes, show that the survey made in 1821 recognized the entrance of the river into the lake through the sand bar in an almost direct line easterly, disregarding the channel west of the sand bar, where the river most usually flowed before the piers were erected.

It is immaterial where the most usual mouth of the river was in 1821; nor whether this northern mouth was occasional, or the flow of the water only temporary at particular times, and this flow produced to some extent by artificial means by a cut through the bar, leaving the water to wash out an enlarged channel in seasons of freshets. The public had the option to declare the true mouth of the river, for the purposes of a survey and the sale of the public land.

Horne v. Smith, 15 U. S. Sup. Court Rep. 988.

Paving Contracts and Limit of City Indebtedness.

Where, in defense of an action to enjoin a city from carrying out a contract for paving, on the ground that it is in violation of the constitutional limitation of the amount of indebtedness that may be incurred by such city, the defendants set up that the cost of the paving is payable out of a special fund assessed against the abutting land, and does not constitute a liability against the city, they must show that the proper steps have been taken to assess the abutting lands, and that the contractor has accepted the fund raised by such assessment, and has waived all right against the city for the cost of the paving.—Atkinson v. Great Falls (Supr. Ct., Mont.), 40 Pac. Rep. 877.

Control of Streets in Pennsylvania.

Under the laws of Pennsylvania, a city has the supreme control over the streets, pavements, etc., and determines in the exercise of its functions everything in connection with their grading, paving, and condition according to its best judgment; and where it chooses to grade its streets so as to leave only a 2-in. depth of gutter, instead of 6-ins., it may do so without being subject to any control of the courts. Though a city may, for any arbitrary or unreasonable arrangement of its grades, which works injury to the property of an abutting owner, be responsible in damages for the injury, the courts cannot take away from the city by mandatory injunction its right exclusively to establish street grades.—McHale v. Easton & B. Transit Co. (Supr. Ct., Penn.), 32 Atl. Rep. 461.

Liability of City for Destruction of Property by Health Officer.

The municipal authorities of a city have no right to destroy the private property of a citizen for the public good without compensating him for the loss thus occasioned, unless the property is itself a nuisance endangering the public health or safety. In that event it may be destroyed by such municipal authorities, without paying the owner its value, if the charter of the city confers upon them the power to abate such nuisances; but even then unless the property is first condemned as a nuisance by appropriate proceedings, its destruction will be at the peril of the municipal authorities; and, when sued for its value, the burden is on them of showing that it was in fact a nuisance, and that its destruction was really necessary to the public health or safety. In cases of emergency the destruction may be properly ordered without a preliminary condemnation, but the municipal authorities will in that event carry the same burden.—Mayor, etc., of Savannah v. Mulligan (Supr. Ct. of Ga.), 22 S. E. Rep. 621.

Injury by Electric Railway to Abutting Property Owner.

The use of a street for an electric railway does not impose an additional burden or servitude to that implied by the dedication. The proper construction and operation on a street where there were two other such railways, and so near an abutting store building as to inconvenience the occupants in receiving and delivering goods, is not such an infringement on the right of access to such building as to entitle the owner to damages based on the consequent depreciation of the value of the property.—Limburger v. San Antonio Rapid Transit St. Ry. Co. (Supr. Ct. of Texas), 30 S. W. Rep., 533.

Selling Municipal Bonds Below Par is Void.

An agreement to sell at their face value municipal bonds with several months' accrued interest is an agreement to sell them for less than par, and is therefore void.—Village of Fort Edward v. Fish (Supr. Ct., Gen. Term, 3d Dept.), 33 N. Y. S. Rep., 784.

WEATHER TABLE FOR MARCH, 1896. (Furnished to Engineering News by the Department of Agriculture.)

	Stations.	Temperature. (Degrees Fahrenheit.) Average.	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average.	Max.	Direction at time of max. velocity.	Precipitation—rain or melted snow—inches. Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	19.9	50	−15	65	12.6	46	N	6.41	1.68	16
	Portland, Me.	28.0	51	7	44	11.3	39	S	8.02	3.50	14
	New York City	32.1	62	13	49	20.1	72	NW	6 13	1.90	17
	Pittsburg, Pa.	32.9	68	9	59	8.0	24	NW	4.13	1.14	17
	Chicago, Ill.	30.8	58	6	52	18.4	57	S	1.26	0.30	9
	Omaha, Neb.	31.6	70	2	68	8.8	34	NW	1.31	0.48	10
	St. Paul, Minn.	25.1	58	− 8	66	9 3	38	NW	2.93	1.26	10
	Duluth, Minn.	22.2	54	− 6	60	12.6	42	NE	1.59	0.52	14
	Bismarck, N. Dak.	19 0	69	−14	83	9.6	44	NW	0.84	0.24	8
	Average.	26.8	60	− 1	61	12.3	44		3.62	1.22	13
Southern Cities.	Washington, D. C.	38.5	70	14	56	11.0	44	NW	5.16	1.34	11
	Louisville, Ky.	40.0	71	16	55	9.8	35	SW	4.86	1.36	14
	St. Louis, Mo.	40 6	74	19	55	12.1	48	SW	2.03	0.68	12
	Savannah, Ga	57.8	88	34	54	9.7	32	S	3.19	1.90	5
	Kansas City, Mo.	38.4	77	12	65	10.0	28	NW	1.09	0.47	10
	Jacksonville, Fla.	60.8	88	35	53	7.6	33	SW	2.51	1.20	6
	Chattanooga, Tenn.	48.1	84	25	59	9.6	37	S	3.21	0.90	11
	New Orleans, La.	61 2	91	41	40	10.3	32	NW	5.29	2.33	9
	Memphis, Tenn.	49.0	78	27	51	12.1	36	W	4.78	1.19	14
	Palestine, Tex.	57.5	84	29	55	8.7	26	SE	1.77	0.79	9
	Average.	49.2	80	25	54	10.1	35		3.39	1.22	10
Western Cities.	Helena, Mont.	28.6	62	−18	80	8.8	40	W	1.71	0.50	8
	Port Angeles, Wash.	39 6	56	18	38	6.7	37	NE	1.72	0.54	11
	San Francisco, Cal.	54.3	72	33	39	8.4	35	SE	2.85	0.84	13
	Salt Lake City, Utah.	40.2	70	14	56	5.9	38	S	1.99	0.34	16
	Santa Fe, N. Mex.	40.5	69	15	54	8.4	40	SW	0.53	0.15	5
	Denver, Colo.	37.2	76	0	76	10.2	60	SW	1.43	0.75	9
	Yuma, Ariz	65.1	99	37	62	7.7	39	N	0.43	0.43	2
	Average.	43.6	72	14	58	8.0	41		1.52	0.51	9

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Published every Thursday at Tribune Building, New York. Entered at the Post Office, New York, as Second Class Matter.

D. McN. STAUFFER, CHARLES WHITING BAKER.....EDITORS.
WM. KENT, E. E. R. TRATMAN, M. N. BAKER, CHAS. S. HILL, A. B. GILBERT.....ASSOCIATE EDITORS.
CHAS. W. REINHARDT.....CHIEF DRAFTSMAN.

GEO. H. FROST, F. P. BURT.....BUSINESS MANAGERS.
ALFRED E. KORNFELD, New York; F. A. PECKHAM, Chicago.....ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE.....Tribune Building, New York.
CHICAGO OFFICE.....1636 The Monadnock.
LONDON AGENCIES: KEGAN PAUL, TRENCH, TRUEBNER & CO. (Limited), Paternoster House, Charing Cross Road; SAMPSON LOW, MARSTON & CO., (Limited), St. Dunstan's House, Fetter Lane.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00; Single copies, 15 cents. To all other countries in the Postal Union, add $2.08 per annum (4 cents per number) to above prices for postage. No club rates allowed. Mailing addresses may be changed at will by sending both old and new address. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 326 means that subscription is paid to the 32d week (that is the issue of Aug 6) of the year 1896; the change of these figures is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes to standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon

The great dredge which is illustrated upon our inset sheet this week deserves the careful study of every engineer in any way interested in dredging operations or the improvement of navigation in alluvial rivers. It far surpasses in its capacity any dredging machine ever constructed, and it is without doubt able to handle material at a lower cost than any excavating machine of any type ever built. The most powerful dredges ever built hitherto have been able to excavate in a day only about as much as this machine handles in an hour, according to its record in the recent government tests.

Of course, it is true that this enormous output is made in the easily-moved alluvium of the Mississippi River bed, and it is evident enough that the dredge would be unsuited for any material where boulders occur of a size sufficient to wreck the cutters.

On the other hand, it appears to be clear that with a different method of operation, the dredge could handle a far larger quantity of material per hour in the Mississippi channel than was recorded in the government tests. For a dredge which can advance so rapidly in making its cut, the old-time system of spud support, or even winding up on a headline attached to a pile is too slow. The dredge should be held by neither spuds or lines, but should be free to move either by its own steam or by tugs alongside. Handling this great dredge on this system and discharging the excavated material through a short length of pipe down stream, it seems reasonable to expect that it would attain a regular output still more marvelous than that already recorded.

As an example of what such a dredge should be able to do on the Mississippi, we may take Mr. Henry Flad's estimate in our last issue that the amount of excavation required to keep a channel open from St. Louis to Vicksburg in a low-water year is in round numbers about 3,000,000 cu. yds. The average output of the dredge "Beta" in the government tests was not far from 6,000 cu. yds. per hour. Allowing ten hours work per day, this would give an output of 60,000 cu. yds. per day, and if a single dredge could be worked daily at this rate, with no delays from any cause, the entire amount of 3,000,000 cu. yds. could be handled in 50 days.

Of course, under actual conditions, a large amount of time is lost in going from one bar to another, getting the vessel in place for work, etc., but making all allowances, it seems reasonable to believe that two dredges of this size should be able to keep a larger channel open from St. Louis to Vicksburg at all times, than the one which the St. Louis syndicate recently offered to maintain for $1,000,000 per annum.

Doubtless the Mississippi River Commission will keep the dredge actively at work during the low-water season this year, and, at its close will have some remarkable records of performance to disclose. They will certainly be looked for with great interest by engineers.

A bill is now in the hands of Senator Pasco, of Florida, providing "That the Commissioner of the General Land Office be directed to cause the Surveyor-Generals of the districts lying in states or territories where the system of public land surveys has been or may be extended, to connect the nearest available corners of such public land surveys with the nearest trigonometrical and astronomical stations of the United States Coast and Geodetic Survey, the United States Lake Survey and the United States Geological Survey." These connecting lines would then be platted on the township maps of the United States Land Office, together with the corrected topography as obtained from the maps of the other surveys referred to. The purpose of such enactment is evident when it is considered that while all these surveys have been made by the general government, they have each been made with a different unit of length and entirely independently of each other. The Coast Survey uses the meter, the Lake Survey uses the foot and its decimals and the Public Land Survey employs the Gunter's chain and links. The absurdity of dividing up the government surveys among different independent departments, each of which appears to be wholly oblivious of the standards and methods of the others, must be apparent to every one. It means a needless duplication of work and a waste of effort and public money resulting in disconnected and practically useless or unavailable maps. It is entirely out of accord with popular demands and with modern ideas of scientific work. We are told that it would be very costly and troublesome to undo the mischief already done, and to reduce all surveys to a common system. But to continue in the present iniquitous practice is to only increase this cost and trouble at some future day, for the change must at some time be made without doubt.

In another and more ambitious bill, introduced by Senator Frye (S. No. 2447), the establishment of a Department of Commerce and Manufactures is proposed, the head of which would be a cabinet officer. By the terms of the bill this new department would have under its direction the Life Saving Service, the Lighthouse Board, the Marine Hospital Service, the Bureau of Steamboat Inspection, the Bureau of Navigation, the United States Coast and Geodetic Survey and the Bureau of Statistics. The State Department would also transfer its statistical work and its Consular Bureau to the new department.

As every one knows, the Treasury Department is one of the most overgrown and unwieldy of any of the executive departments. What the custody of the public funds, which was the original function of the Treasury Department, has to do with the Steamboat Inspection Service or the Marine Hospital Service, is something which it would puzzle a Philadelphia lawyer to explain. The same may be said of a half-dozen other bureaus which have grown up in the Treasury Department, the Interior Department and to some extent in the War Department. The State, Navy, Post Office, Agricultural and Law Departments are properly organized, and each is in charge of its own especial sphere of work, in which it interferes in no way with its neighbors; but in the other three departments named a thorough overhauling is urgently demanded. The Treasury Department should undoubtedly be relieved of all the numerous bureaus which now demand so much of the time and attention of its chief officers, and should be confined solely to the custody of the public funds, the collection and distribution of the revenue, and similar duties which come properly within its scope.

But as to the question what to do with these various bureaus, together with those which the Interior Department has gathered to itself, we are by no means clear that Senator Frye's bill presents the best solution. The fact is that all the work in connection with commerce and manufactures should be under a single department head, and the same thing is true of all the engineering work which the government carries on. Suppose, for example, that the name of the Interior Department were changed to the Engineering Department. Suppose its Pension Bureau were turned over to the War Department and its Indian affairs to the State Department, where both of them properly belong. It would then have left the Geological Survey, the Land Office, the Census Bureau, the Patent Office and the Commissioners of Education and of Railroads, the latter a useless office since the Interstate Commerce Commission was established. Suppose now, that a redistribution was made of these departments and of those taken from the Treasury Department as follows:

Department of Commerce, Statistics and Manufactures.	Department of Engineering and Public Works.
(1) Bureaus of Statistics in the Treasury Department and in the State Department, together with Census Bureau in Interior Department and the Bureau of Labor to be consolidated under one head, which should collect and compile all statistics and maintain the work of the census on a permanent basis.	(1) Construction of Public Buildings, present Supervising Architect's office.
(2) Bureau of Immigration.	(2) Government Surveys, consolidating under one head, the Coast and Geodetic, the Geological and the Public Land Surveys.
(3) Bureau of Navigation.	(3) The Lighthouse Board.
(4) Life Saving Service.	(4) Steamboat Inspection Service.
(5) Marine Hospital.	(5) River and Harbor Improvement Works, now under the War Department.
(6) The Patent Office.	
(7) Bureau of American Republics.	
(8) Bureau of Education.	

That some such reorganization as the above, designed to bring bureaus engaged in the same general class of work under a single head, ought to be brought about, every careful student of the problem must concede. We confess that we have little hope of seeing so radical a reorganization effected, at least for a long time to come, for the opposition of thousands of office holders would at once be enlisted against it; on the other hand, it is not clear why some such reorganization might not have quite as good a chance of success as the half-way measure that Senator Frye has brought forward. The present Congress appears to be destined to become famous for the things it has omitted to do rather than the legislation actually enacted; and if its members really want to do something to make their names worthy of grateful remembrance by posterity, we suggest that they take up Senator Frye's bill, remodel it in some such manner as we have suggested, and bring order out of chaos in the organization of these important executive departments.

We present in another column the claims of the contractors for the New Croton Aqueduct against New York city, as contained in a long personal letter sent us by one of these contractors. We do this partly because we were ourselves misled by published statements as to the real points at issue, and partly because the matter of contention itself is of interest to engineers and contractors. We have been compelled to condense the statement furnished us; but we have endeavored to preserve the essence of the document, and we leave the writer responsible for the presentation made. According to this letter it appears that, contrary to general rumor, these claims have no connection with defective work done upon the aqueduct, or with the compulsory repair of such work. The point at issue is merely the area of tunnel excavation to be allowed the contractors. At one time the commission allowed and the engineers approved of a certain allowance outside of a certain typical cross-section represent-

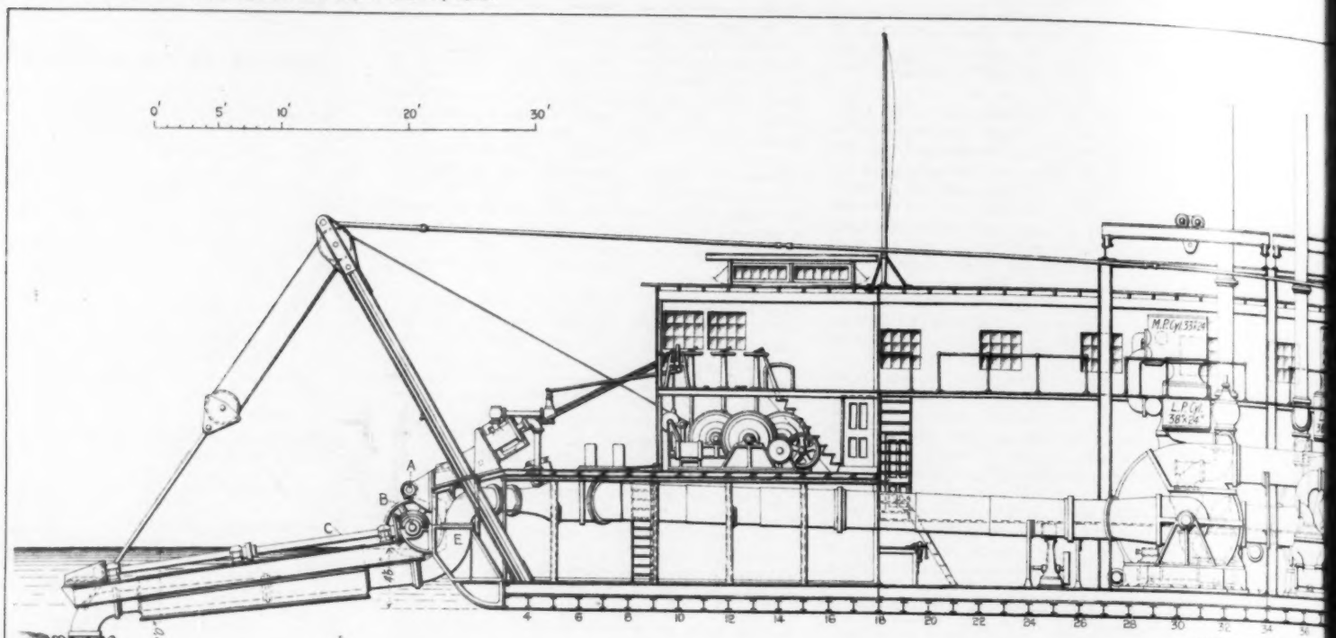


FIG. 2. SECTIONAL ELEVATION.

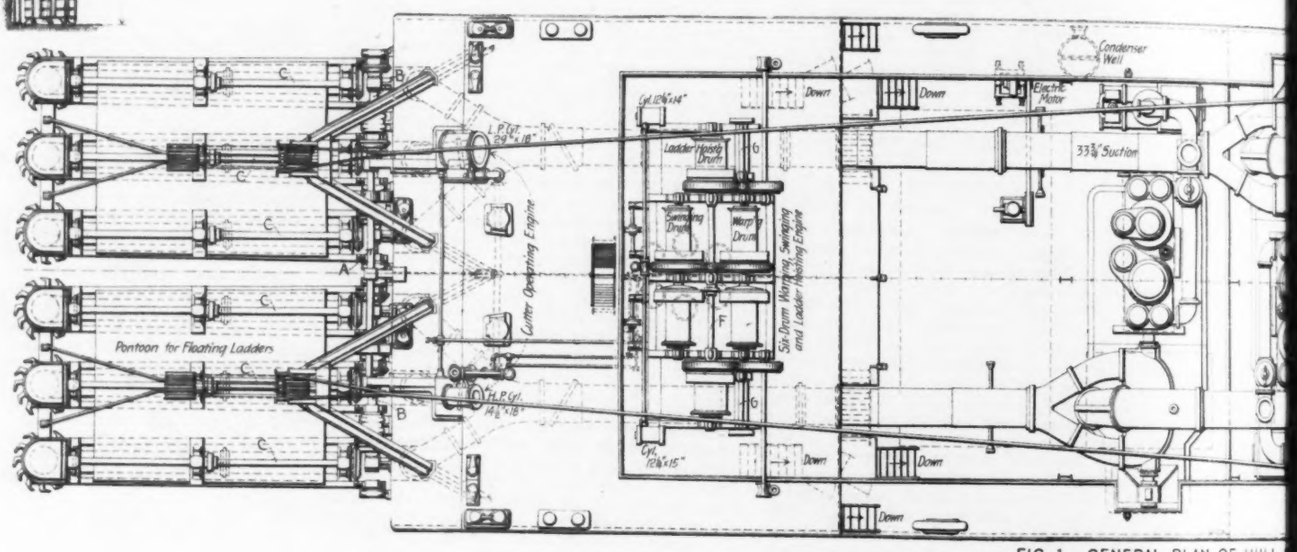


FIG. 1. GENERAL PLAN OF HULL SHOWING

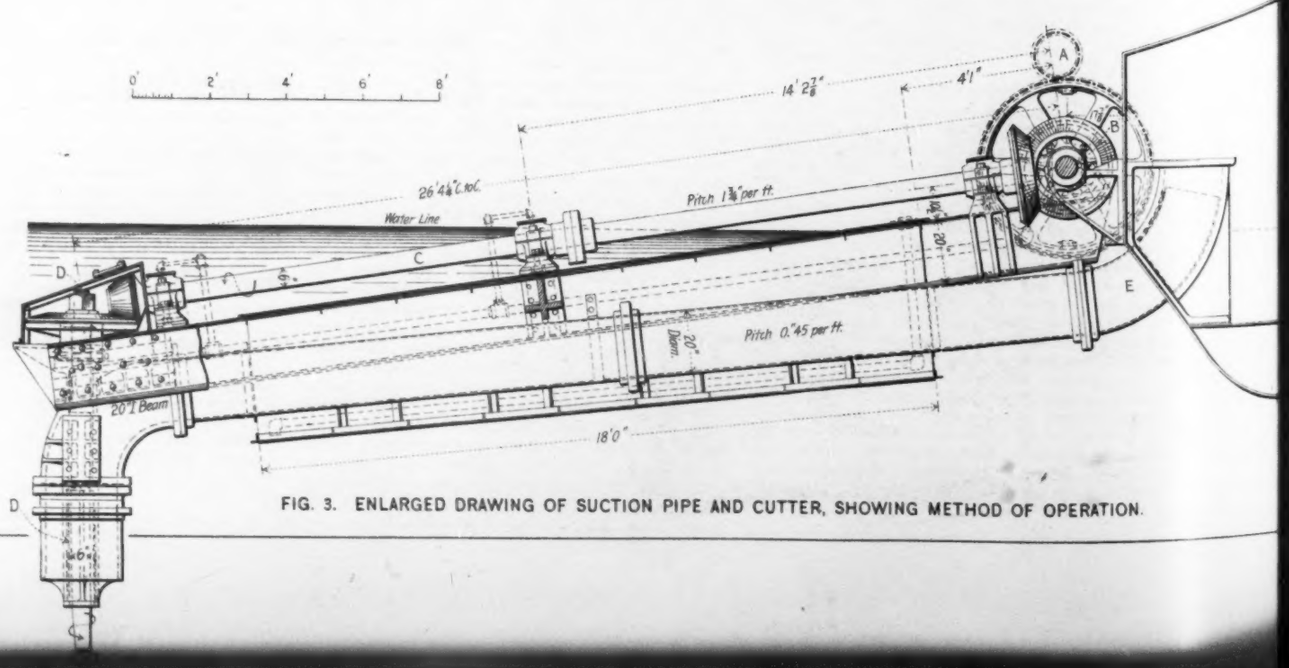
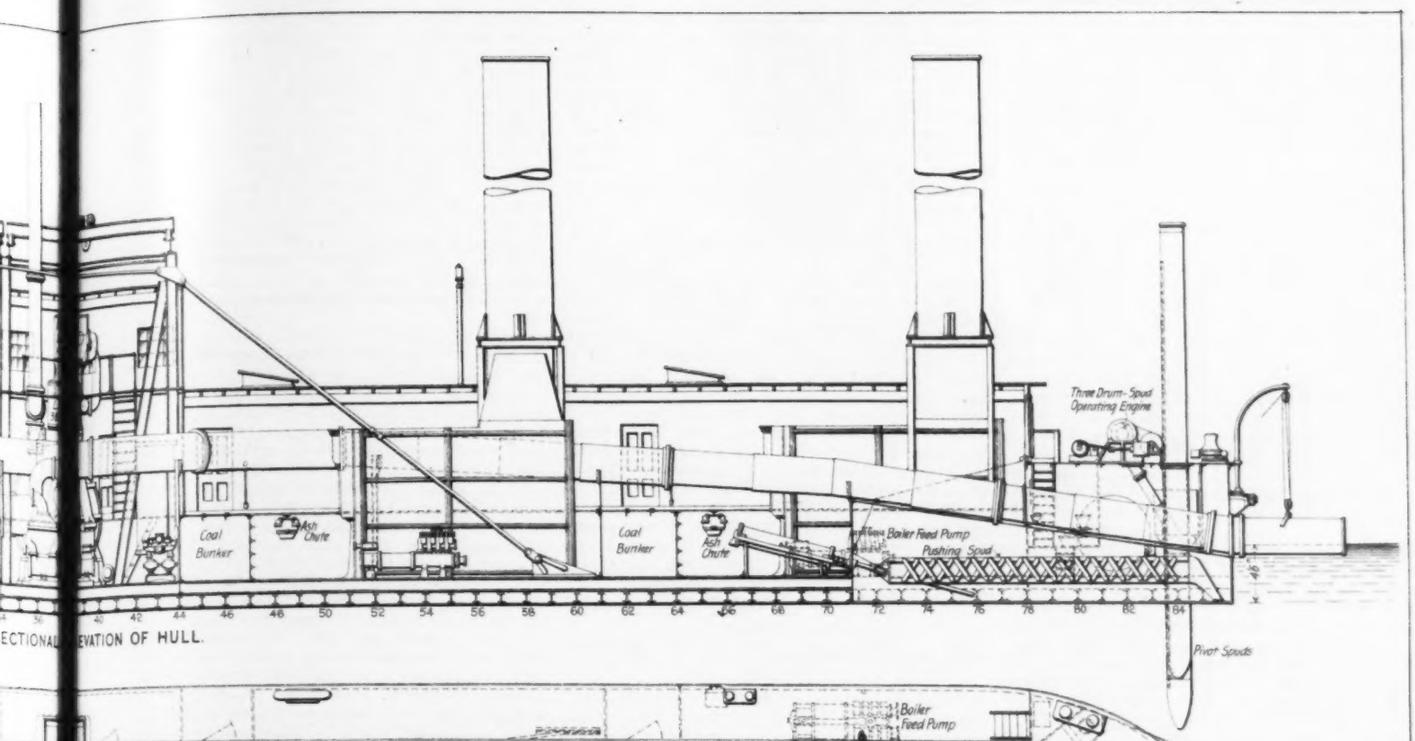
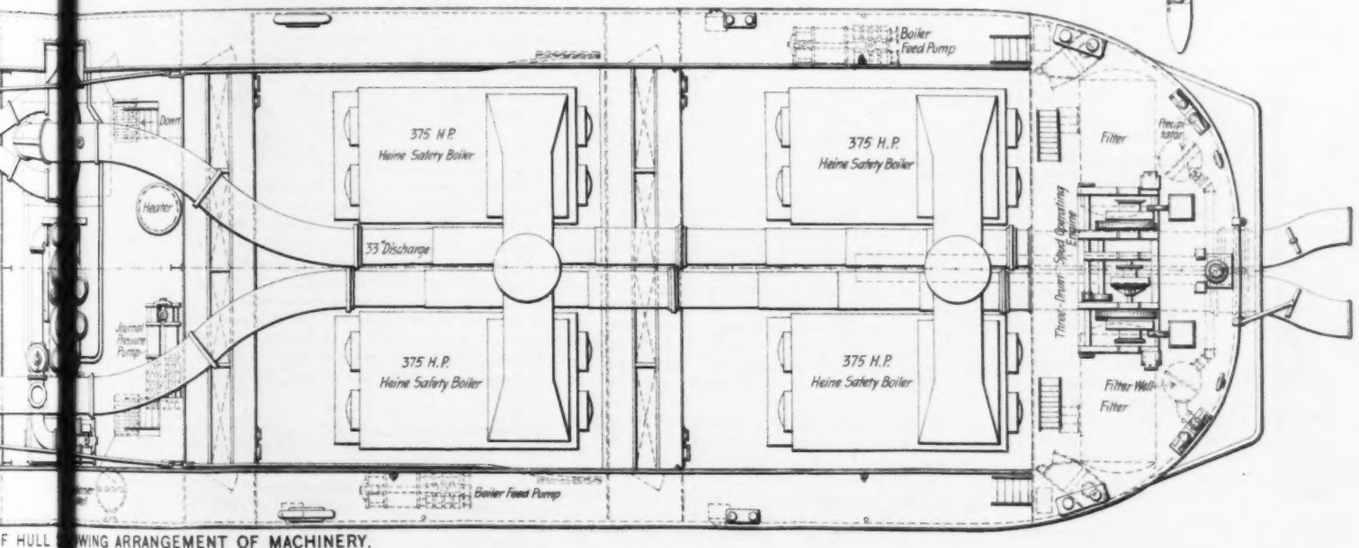


FIG. 3. ENLARGED DRAWING OF SUCTION PIPE AND CUTTER, SHOWING METHOD OF OPERATION.

GENERAL LIBRARY,
UNIV. OF MICH.
25 APR 1896



ECTIONAL EVATION OF HULL.



F HULL SHOWING ARRANGEMENT OF MACHINERY.

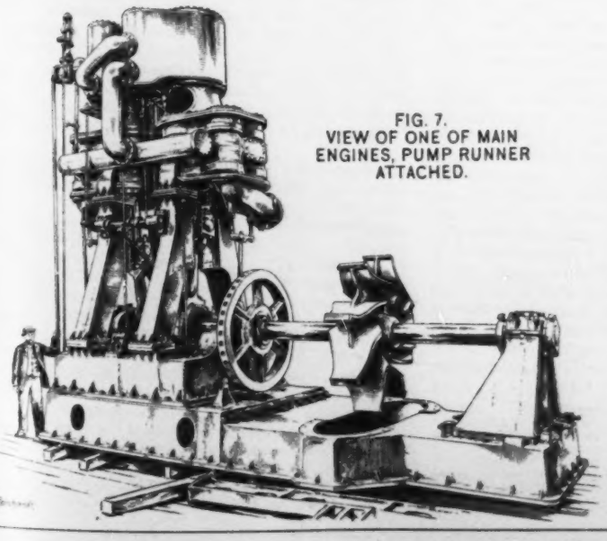


FIG. 7.
VIEW OF ONE OF MAIN ENGINES, PUMP RUNNER ATTACHED.

HYDRAULIC SUCTION DREDGE FOR NAVIGATION IMPROVEMENTS OF THE MISSISSIPPI RIVER.

Lindon W. Bates, Chicago, Ill.,
Designer and General Contractor.

The Maryland Steel Co., Sparrows Point, Md.,
Contractors for Construction.

CHAS. HART & SONS, LITH., 20 VESEY ST., N. Y.

ing the conduit and including the space occupied by masonry "necessary to preserve the shape of the conduit against the pressure of the surrounding medium." On this allowance, which was figured as equivalent "to a general thickness of 20 ins. of masonry around the inside area of the aqueduct," all the preliminary estimates were made as the work progressed, up to the completion of the tunnel excavation. Later, a new commission reported against this allowance, under the advice and interpretation of the contract by a new counsel to the corporation, and the allowance was reduced to 12 ins. in the engineer's estimate, on which final payments were made. The contractors now claim the difference between what was originally allowed them and what was finally paid for.

Both of these contrary decisions can not be right; but which one is in strict conformity with the terms and intent of the contract we have not sufficient data at hand to decide. Assuming the case to be as stated, it would appear that the engineers who originally framed the contract, and who should best know what that document really meant, decided upon and approved one typical cross-section; and that later the commission and Corporation Counsel decided upon a different and smaller cross-section and made the final payments upon it. In this case the last area allowed reduced the contractors' estimates and saved money for the city; but the same power might equally have been exerted, under other conditions, to largely increase the contractors' profits. The vital question to be settled in this case is as to whether the engineer or the lawyer is to be the final authority in finally setling so thoroughly technical a matter as fixing an area of tunnel excavation, according to the provisions of a contract drawn up by the engineers whose original verdict was upset by the later decision. We cannot decide such a question, though our inclination is to back the engineer as the best fitted to judge in such cases. But neither can an average legislative committee decide; and, as we have before stated, if the principle be once established that by special legislation a commission can at any time be appointed to upset the decision of an engineer in interpreting contracts or to give a final vote upon such engineering problems, a serious blow would be struck at the stability of contract obligations.

Full justice should be awarded the contractors in this and in all cases; but they should be able to secure justice in the courts, and to have the legislature interfere after the courts have heard and decided the matter appears to establish a dangerous precedent.

Among the letters published in our correspondence column in our last issue was one inquiring concerning the course of the Montreal Bridge Co., with respect to the designs submitted by engineers for the St. Lawrense bridge in response to the company's prize offer a year or more ago. Since this letter was published we have received a communication from the Managing Director of the company, in which he states that his absence had prevented a reply to the proof of the communication which was sent to him. He further states that the company has not yet received the decision of the Canadian Government with reference to the plans submitted to them. The decision is expected shortly, however, and as soon as received the prize-winners will be announced.

The constitution and system of administration of the Institution of Civil Engineers has probably by this time been changed in several important features through action at the meeting of that society, which takes place this week. Thanks chiefly to the exertions of the President of the Institution, Sir Benjamin Baker, the council has been increased in number so that it may be more representative of the membership, and the letter-ballot has been given to all members residing in the United Kingdom. The Institution has about 6,000 names on its roll of members, yet, under the old constitution, the 1,300 men residing in or near London nominated and elected all officers and decided upon all matters of administration. With its President and four Vice-Presidents and 15 other members the old council numbered 20 men, and the duties were so onerous that at least 17 of them had to reside in or near London. The widely-scattered membership outside of London simply paid their dues and received the publications of the Institution. Sir Benjamin Baker pointed out that, on the late council, one locomotive engineer represented the enormous staff of chief and assistant engineers on the railways of the British Empire, and there were no representatives at all of the vast iron and steel industry, of mercantile shipbuilding and marine engineering, or of the mining engineers. The changes proposed increase the effective force of the council to 27, or to 35 members, as the case may be, and provide seats for members not residing in London. Only an interval of four weeks is allowed between the presentation of the list of candidates and the time fixed for the opening of ballots at the annual general meeting; but this admits to a letter-ballot the 2,600 members residing in the Provinces, Scotland and Ireland, while Canada and the United States might possibly get their votes in in time. The 1,000 and more members residing in India, Australia and other remoter parts of the world must be content, as before, to do without voting. The spirit shown in breaking down tradition and in requiring at least seven of the candidates presented to be men who have not served in the current or preceding council, is promising of a more vigorous life and a broader interest in the affairs of the Institution. And judging from its recent publications it needs this infusion of new blood.

THE WORK OF THE TEXAS STATE RAILWAY COMMISSION.

The state of Texas has for some time enjoyed an unenviable reputation for its treatment of the railway companies, operating within its borders. During the decade ending in 1890, the state was the scene of extensive railway building operations. Every town and city of any size was eager for railway lines. The real estate boomers and the railway promoters had things their own way, and state railway control was ignored; but with the end of the season of reckless railway construction, a new element got the upper hand, and Texas for a season bid fair to rival the work of the granger states of the Northwest a dozen years earlier in the extremity of the measures which it was proposed to take in the controversy of The People vs. the Railways. It is partly the attacks upon the railways by politicians and public speakers during this era, and partly the misrepresentations of the real attitude of Texas toward the railways that have given the state its bad name in this matter.

As a matter of fact, after a careful examination of the last report of the Texas railway commission, we are constrained to believe that this bad name is undeserved. If the attitude of the state toward the railways is correctly set forth in the commission's report, we are free to say that the position is economically and politically correct, and that other states and state railway commissions can profitably study the work that has been done in Texas.

It may be said at the outset, that the Texas commission has attempted a task which has never been attempted before anywhere, and that is to base railway rates upon the cost of service. The position of the commission is that the railways are entitled to charge rates high enough to return a fair rate of interest on the actual value of their property, and no higher. By value is meant not the par value of outstanding stocks and bonds, nor the amount of money which has been actually spent and charged to capital account; but it is what the entire plant of the railway company could be duplicated for at the present time.

That this principle is a sound and safe one, and equitable to both the railways and the public, all careful students of the railway problem will generally agree. That the Texas commission is willing to adhere to it and carry it out impartially, the following extract from its report bears witness:

> While it is the duty of this commission, as far as it has authority to do so, by its rates and rulings, to protect the public against discriminations in rates and service between shippers, and against excessive freight charges, it is equally its duty to establish and maintain such rates as will secure to the railway corporations a proper return of interest on the capital invested, if the condition of the roads with reference to population and business will enable it to do so. And it would not hesitate, if it should be shown to be necessary, to increase rates for this purpose. This commission has often stated to the freight agents and traffic managers in its meetings with them that if the railway companies engaged in interstate shipment would make and maintain rates which would be fairly compensatory to them on such shipments, this commission would do all in its power, by its rates, to secure them reasonable revenue on their railway investments in this State. And we now repeat that statement. But this suggestion contemplates good faith on both sides in the making and maintenance of rates.

That the principles above stated have been carried out in practice, as far as the commission is concerned, appears to be shown by the figures in the report, and it is stated that notwithstanding the important reductions in freight rates (some of which were made by request of the railway companies) the returns show an increase in revenue. Rates are not always lowered by the commission, but in some cases are as high as, or higher than, those which were in force before the railways were subject to regulation. This has been on account of the necessity of preserving rates which have long been in force on account of competition or other local conditions. These cases are quite limited in number. There has been steady increase in both gross and net earnings per mile in Texas, as compared with the equally steady decrease for the whole United States.

The valuation of the railways, as instituted by the commission, was fully described in our issue of March 7, 1895, and the present report states that of 47 railways thus valued, the net earnings for 1895 were 7.449% on the commission's valuation of $140,300,000, and 14.221% on the valuation of $68,560,000, as rendered for taxation. In round numbers these roads have outstanding stocks and bonds amounting to 2½ times their value, as determined by the commission, and more than five times their value as rendered for taxation.

The Texas railway commission, in connection with its valuation of railway property, gives careful consideration to the condition of such property, and has systematic inspections and examinations made by its engineers. There is, of course, a very great variation in physical condition. Rails, for instance, vary from a worn-out 30-lb. section to a new 70-lb. section. Maximum grades vary from 0.6 to 2.5%. While there is much good track in the state, and while a general improvement is being made as enforced by the increasing weights and speeds of trains, yet much of the track is stated to be in an unsatisfactory condition, some of it absolutely dangerous or only reasonably safe at very moderate speeds. In two cases, serious accidents occurred at points which had been reported as dangerous by the engineers of the commission. It is true that the poor track is largely due to the poverty of the individual road, but, on the other hand, a considerable proportion is on the branch lines of wealthy corporations amply able to make the necessary improvements. The commission considers that, for equal charges, the service rendered the people is more variable than there is just occasion for. It has long been recognized that public opinion has considerable force in inducing railway companies to introduce improvements (as experienced notably in England), and publicity in regard to the improvements made on Texas railways is attained by requiring the companies to furnish in their annual returns (which are published in the report of the commission), particulars as to rail and tie renewals, bridges, trestles, etc. The weight of rail and number of tons laid are reported, together with the cost at the distributing point, and the number and material of ties renewed, with cost per tie, are also given. The statement as to general conditions of alinement and grade, coupled with the returns as to fuel consumption per mile for engines in passenger, freight, switching, construction and mixed train service, enable some comparisons to be drawn as to economy in operation. There are now 8,386 miles of steel rail to 905 miles of iron rail in main track, but 435 miles of steel to 840 miles of iron in yards and sidetracks.

The cost of railway transportation is taken up by the commission, and considerable information is on file in regard to this matter. The range is very considerable, for while the Galveston, Harrisburg & San Antonio Ry. reports the actual cost per train mile at 94 cts. (with an actual gross

revenue of $1.39), the Missouri, Kansas & Texas Ry. gives $1.15 (with $1.29 gross revenue), and the Galveston, Houston & Henderson Ry. gives $2.06 (with $2.78 gross revenue). The percentage of operating expenses to gross earnings ranged from 30.93% to 237.26%, the average being 73.28%. From the statistics collected, certain average results are clearly ascertained, as follows:

1. The average legitimate cost of railway operation per train mile, in Texas (exclusive of fixed charges) should be less than $1.

2. The average operating expenses should not exceed 70% of the gross earnings.

3. The normal distribution of operating expenses should be about as follows: 60% for train expenses (including maintenance of equipment), 25% for maintenance of way, and 15% for general expenses.

4. Not more than 50% of the operating expenses should increase directly as the traffic.

The report also contains an account, which we cannot reproduce at length, of the operations during the year under the Texas bonding law. We believe the state has gone farther than any other state of the Union with respect to the restriction of railway bonding. Under the Texas law no bonds can be issued on any railway line for a greater amount than its actual value as determined by the commission. Any one familiar with the water that has been injected into the capitalization of almost every railway corporation in the country at some time in its history through bond issues, will confess that Texas is attempting to remedy a very real and serious evil; every one will watch with interest to see what measure of success is attained in the work that she has undertaken.

LETTERS TO THE EDITOR.

The Significance of the Term "Factor of Safety."

Sir: The letter from Messrs. Levering & Garrigues in your issue of April 2, where these gentlemen explain how the figures in their table are arrived at, makes me think how much better it would be if all such tables bore an indication of the formula or principle followed in their preparation. In the special case referred to, nothing is given except the words: "Factor of 6," while the beam table on same sheet is marked: "In accordance with New York Building Law." But even the "factor of 6" is misleading, on account of the extra ⅛ in. of metal allowed on all columns to cover shifting of the core. The factor would really be about 7, according to the usual meaning of the word "factor of safety," which to my mind is the quotient obtained by dividing the actual or probable exterior forces into those the structure would be able to sustain if quality of material and workmanship were perfect. Yours truly, F. Sodemann.

315 East 28th St., New York City, April 6, 1896.

Formulas for Computing Angles With Unequal Legs.

Sir: I send you, herewith, a blue print showing the derivation of the formulas for finding the main axes and the main moments of inertia of angles with unequal legs. I have not as yet seen a pocket book in which the tables for these items are correct. One instance you will note by referring to column 14, pp. 103 and 104 of the 1895 edition of the Carnegie Steel Co.'s Pocket Book.

Very truly yours,
Thos. Marshall's Foundry & Structural Works.
C. Schnike, Engineer.

Pittsburg, Pa., April 13, 1896.

(The blueprint sent by our correspondent shows a detailed mathematical solution of the problem of finding the main axes and the main moments of inertia of unequal leg angles. We presume any of our readers interested can obtain a copy of the blueprint by applying to Mr. Schnike.—Ed.)

Amount of Paint and Labor Required in Painting a Train Shed Roof.

Sir: Several articles have recently apppeared in Engineering News on the covering capacities of paints, and the following figures may be of interest in connection therewith. The Jacksonville Terminal Co. has a wooden passenger shed at this place 1,050 ft. long, 570 ft. of which is 140 ft. wide between outer posts, and 480 ft. is 65 ft. wide between posts. The roof is covered with tin, except the center skylight roof which is glass, and had been previously painted; but most of this coat of paint had worn off, and rust was showing in many places. The tin was first rubbed with palmetto brushes, and then swept, to give a clean surface. Pure raw linseed oil, Lieska's Terebine dryer, and Prince's oxide of iron were used, mixed in the following approximate proportions: 5½ lbs. dry oxide to 1 gallon linseed oil, and 1 gallon dryer to 10 gallons oil. The roof contained 151,000 sq. ft. of surface and was covered with two coats. The materials used were:

396 gallons linseed oil.
35 " Terebine dryer.
2,120 lbs. dry oxide of iron.

From measurement it was found that oxide of iron mixed with linseed oil in the proportion of 5½ lbs. oxide to 1 gallon of oil gave an increase of liquid paint of 1 gallon to every 16 lbs. of oxide added. Using this we have:

396 gallons oil.
35 " dryer.
132 " (due to addition of 2,120 lbs. oxide).
563 " paint used on roof.

The number of square feet covered with two coats being 151,000, we have an average of 267.2 sq. ft. covered with two coats by each gallon of paint.

The actual time consumed in mixing and applying the 563 gallons of paint was equivalent to 1 man working 158 days of 9 hours each, exclusive of foreman. This gives an average of 1,921.4 sq. ft. covered with one coat by 1 man working 9 hours. Yours truly,

J. M. Braxton.

Jacksonville, Fla., April 7, 1896.

The Efficiency of the Compressed Air Power Plant At Grass Valley, Cal.

Sir: After about three months working of the water-power and compressed air-transmission plant, described in your issue of Dec. 19, 1895, I am able to give the following figures with reasonable assurance of their accuracy.

The reheating of the air is found to cost almost precisely 1 ct. per day per horse power (theoretical) of the water used, or 1 1-3 cts. per day per HP. of work actually done by the motors.

The following efficiencies do not include the above cost of reheating:

Efficiency of compression and transmission from water-wheel to motors.....79.5%
Efficiency of compression and transmission from the theoretical power of the water to the motors....74 %
Efficiency of compression and transmission to and through motors 71.6%
Efficiency of compression and transmission from the theoretical power of the water to and through motors..... .....66.6%

Putting it in plain English, we have 304 theoretical HP. in our water and we obtain 202.7 HP. of work actually done at the mines. The efficiency of the water-wheel is a trifle over 90% at all loads from one-fourth to full. Very truly yours, etc.,

Grass Valley, Cal., April 9, 1896. A. D. Foote.

The Providence Experiments on the Mechanical Filtration of Water.

Sir: I have just read your interesting review of my report. There are two statements about which there seems to be a misunderstanding. You refer to substituting unfiltered water for filtered water for washing the filter. This is not correct. I included the cost of filtered water in my first and last estimates. You probably misinterpreted my statement on p. 176 of my report where I mention "rewash water." The "rewash water" is not the water used for washing the filter, but the water that is allowed to run to waste after washing the filter (2.9%). During all of the experiments unfiltered water was used as the "rewash water." In my first estimate I considered the "rewash water" as filtered water in order to be sure and have my estimates high enough, and I was informed that it was customary to do so, but after thinking more about it I came to the conclusion that this was theoretically wrong as unfiltered water was necessary in order to have the "free flow" do its work properly, and as I intimated above that this course was followed during the experiments, which produced excellent results.

You also state near the top of the third column of p. 263 of your paper "bacillus prodigiosus" was added to the applied water, and an average of 96% of these were "removed." On p. 118 of my report (near the bottom) will you notice that the 96% is the reduction of water bacteria while bacillus prodigiosus was being used, and on p. 131 in the last paragraph that at least 99.8% of the bacillus prodigiosus was removed. In other words, the above 96% and 99.8 cover the same period, the water bacteria and bacillus prodigiosus being counted separately in the cultivation of applied and filtered water.

Very truly yours, Edmund B. Weston.

Providence, R. I., April 17, 1896.

(Mr. Weston was wholly justified in basing his final estimate on using unfiltered water for the "rewash," or during the period when water was being wasted after washing. We did not note the significance of the word "rewash." We also misunderstood the figures regarding bacillus prodigiosus.—Ed.)

Engineering as a Close Profession.

Sir: The subject discussed in your editorial and a communication, under the head of "Engineering as a Close Profession" (issue of April 2, 1896), is one in which I am much interested. My ambition is, to some day be a recognized engineer. It has been impossible for me to obtain a university training, but I have tried for a period of ten years' study, and practice with engineers, to prepare myself for the profession. While I would not yet call myself an engineer, I profess to have a greater technical knowledge than is required for a surveyor or a draughtsman and would gladly hail an opportunity to undergo an examination in purely technical subjects to obtain a diploma and an official recognition as an engineer. Very respectfully, T.

Sir: In your issue of April 2, p. 226, I notice a copy of a letter on "Engineering as a close profession." As another "M. Am. Soc. C. E.," I desire to express my sympathy along this line. A difficulty that I have met is that engineers of considerable ability, holding practically permanent positions with some municipality or corporation, will do outside work, and oftentimes at prices with which another engineer who depends upon such practice, and has no municipal position to fall back upon, cannot compete. You can see at once that as between the two men, there will be necessarily a considerable difference in expenses, due to office rent, hire of assistants when not at work, and also lost time. It seems to me this practice at least should be frowned upon by engineering societies.

I have no objection to an engineer being called upon by parties on account of his professional ability; but in such a case he should be very careful to make his price at least as much as his less fortunate brother engineer.

While on this subject, I would say that I have held for a good many years that a young man graduating from a scientific school should be given a degree that should indicate that he has pursued for a term of years the study of engineering. This degree, however, should not be "C. E." Three to five years after his graduation, if still pursuing the profession of engineering, I would have him present himself, not to a professor of engineering, but to a Board of Engineers to be chosen (for example) by the Board of Direction of the American Society of Civil Engineers, and submit to such an examination as they may prescribe. Passing such an examination, I would then give him the title of C. E. The title of C. E. would then mean something.

Respectfully, "Another M. Am. Soc. C. E."

Engineering Nomenclature Again.

Sir: In my opinion Mr. Theodore Cooper is sound in his observations regarding the word "lineal," as set forth in his letter contained in your last issue. I was not aware that the Am. Soc. C. E. ever had a publication committee with so little poetry in their souls as to delete the euphonious "lineal" and substitute its harsher co-partner, "linear."

I have made this distinction in using the two terms, of applying the term "linear" to determinate dimensions in straight lines, say, a horizontal plane, as from center to center of the bridge towers; whereas "lineal" is of more inclusive scope as referring to the dimension taken along the cables or the roadway, or the sinuous contour of a pipe-line.

This view of the case appears to be justified by the Century Dictionary; also by comparison with such relative terms as "radius," implying a fixed dimension, versus "radial," a general reference to a line or lines projected from a center towards a circumference; and of the same sense are the terms "diameter" and "diametral;" the latter being well established in designating the gear system, diametral pitch.

I hope we may hear from Mr. Cooper again on this subject, without limitation as to lineal dimensions—depth, breadth or length. But may the dimension of his linear shadow never grow less.

Yours respectfully,
John Thomson.

253 Broadway, New York City, April 15, 1896.

Sir: Continuing the discussion on the incorrect use of words and expressions in engineering, it may not be amiss to refer to "speed." The definition of this word is practically the same as that of "velocity" ("rate of motion"), and yet the expression, "rate of speed," is used largely by engineers, and I think quite generally by the newspapers. A few months since it even crept into the front page of an issue of your wonderfully accurate paper.

Engineers seem to say, as a rule, "a ten hours' journey," but "a 50-ft. span." As people of literary distinction would say, "a 50 feet span," I would be glad to learn why our modern engineers, even of the highest standing, prefer "foot" to "feet" in this connection.

Yours very truly, N. W. L. Brown.

Atlanta, Ga., April 13, 1896.

(We have good authority for the use of the term "rate of speed." The word "speed" has other meanings than "rate of motion," and one of them is rapidity of movement; quickness of mo-

tion: swiftness. It would be perfectly correct to say "rate of rapidity of motion," then why not "rate of speed," which is more euphonious? But the "Century Dictionary" itself uses the term "rate of speed" in the following definition:

4. Rate of progress or motion (whether fast or slow); comparative rapidity; velocity; as, moderate speed, a fast or a slow rate of speed; to regulate the speed of machines.

The expression "a 50-foot span" is good idiomatic English. It has been used by the best writers probably for centuries, and if any "people of literary distinction" say "a 50-feet span," they violate the idiom of the language for the sake of a rather far-fetched purism. If we should receive a manuscript containing the expression "a 50-feet span," we would before printing it change "feet" to "foot," just as we would correct an obvious error in spelling or grammar.—Ed.)

The Steel Manufacturers' Specifications for Steel.

Sir: In your review of the specification of the Association of American Steel Manufacturers, in your issue of April 9, you have pointed out its most salient defects, but there are many others which are also worthy of consideration.

In the first place, a purchaser ordering structural steel under this specification does not know what kind of steel he is going to get, nor anything about its chemical qualities. As long as it is one of four kinds of steel fulfilling moderate physical requirements he has to take it. Again, the very limited number of tests which is allowed, and to which you call attention, must be made prior to shipment, and after that it is "hands off."

The clause requiring the annealing of test pieces taken from material which is subsequently to be annealed, is probably particularly aimed at eye-bar material, and is objectionable. The annealing of test pieces may be made to cover many defects of quality and treatment, and it is almost certain that such annealing does not represent the final annealing of the material.

It is noticeable also that the "reduction of area" has disappeared in this specification. Ordinarily the reduction is not of importance, but there are cases in which it is the only protection against badly treated steel. The reduction of area is a definite and well-known function of a tension test, and there is no good reason for not retaining it in, at least, a reasonable and moderate form.

Limiting the test from a steel pin to a depth of 1 in., indicates that the manufacturers are familiar with the peculiar condition of the interior of such material. With this specification there should be no more trouble with eye-bars, at least not until the manufacture and testing are complete, and they are out of the manufacturers' hands.

With an annealed test piece, a variation of 10,000 lbs. in specimen test, and an allowed drop of 5,000 lbs. in the full-sized test, there is a possible range of ultimate strength of 20,000 lbs. The required stretch of 10% is likely to take place before rupture if the required ultimate is reached, so that a few fractures in the heads of bars will be of no importance. Of course, only one-third of any lot of bars are allowed to break in the head, so that some little care must be exercised in making them.

You urge the necessity of testing every plate used in boiler work, giving as reasons the possible mixing of ingots and slabs in the mill, and the variation due to hot and cold finishing. A farther and fully as important reason for testing every boiler plate, is the non-uniformity of individual ingots. Where there has been no mixture at all, and the steel has been made in good faith for boiler work, it is still possible for the lower two-thirds of an ingot to be suitable for boilers and the upper third unsuitable, and the larger the original ingot the more likely is this condition to exist.

An abstract of the two grades of structural steel required by this specification is as follows:

Soft Steel.

Ultimate strength, 52-62,000 lbs. per sq. in.
Elastic limit, not less than one-half the ultimate strength.
Elongation, 25%.
Bending test, 180° flat.

Medium Steel.

Ultimate strength, 60-70,000 lbs. per sq. in.
Elastic limit, not less than one-half the ultimate strength.
Elongation, 22%.
Bending test, 180° around once the thickness of test.

If the object of the manufacturers was to make any and all steel acceptable, I think they might have introduced the following conditional clause to advantage:

Material made for soft steel, but which shall give a higher ultimate strength shall be accepted, provided it gives the required elongation and bend. Material made for medium steel, but which shall give a lower ultimate shall be accepted, provided it gives an elastic limit of 30,000 lbs. per sq. in.

This would save nearly everything from rejection.

Yours truly,

A. C. Cunningham, C. E., M. Am. Soc. C. E.

Albany, N. Y., April, 16, 1896.

(The Steel Manufacturers' specification was noted in our column of "New Publications" in our issue of April 9. For the benefit of any of our readers who may have not secured a copy, we will repeat that they may obtain one by applying to any of the prominent steel manufacturing companies.—Ed.)

Improving the Mississippi River by Contract.

Sir: While I agree substantially with what you have said editorially in your issue of April 16, on the improvement of the Mississippi River, and also with the views of Col. Henry Flad, abstracted in the same issue, yet neither of these statements are pertinent, it seems to me, to the present question which the citizens of St. Louis are urging upon Congress. The question now is whether or not it is wise to let out the improvements of the Mississippi River by contract. The Mason-Samuel bill, as originally drawn, never commanded much of a following, and was not even considered by the Rivers and Harbors Committee of the House. Before Col. Flad's statement was presented to the committee the St. Louis delegation had practically withdrawn this bill and were simply asking that the work be advertised and let to the lowest bidder who would furnish a sufficient guarantee, and who would do the work under a total forfeiture if unsuccessful. This is now the only question to be discussed. Since some fifty sand-bars have to be operated upon every year south of St. Louis, and the work must all be done in a few weeks' time, it is evident to some of us who are pretty familiar with government methods that we have no assurance of success under direct government auspices. Neither do we believe that the government is able to do the work as cheaply as a private individual or company could do it. Whether such individual or company would make or lose money is not to the point. The only question is by what means is a successful performance to be absolutely assured? The cost in any case is but a bagatelle as compared to the benefits, if a good navigable channel at all seasons can be relied on and obtained. The perpetual future uncertainty is as great a hindrance to a revival of the river industries as an occasional actual stoppage. No man will now invest capital in river transportation facilities because of this uncertainty. St. Louis has loyally supported the Mississippi River Commission for the past 17 years and we now experience "that tired feeling" which eventually comes to the most enthusiastic and long-suffering individual doomed to continual disappointment. In the perpetual, annually recurring, war with the mighty forces of the Mississippi River, which we are now asked to face, we do not believe the government agencies are adequate to a complete and continued success. How long should we wait to determine this fact? We have now waited till our tow-boats and barges are rotting at our river front, and our elevators are standing empty and bankrupt at the water's edge. The more expensive rail-routes to the seaboard are absorbing many millions of dollars every year which should go into the empty pockets of our farmers who are now charging to the greed of the "gold-bugs" a poverty which should be largely charged to the shallow and obstructed channel of the Mississippi River. I believe that private enterprise, and that only, is able to accomplish this great and beneficent work

J. B. Johnson.

St. Louis, April 18, 1896.

(We believe it may safely be laid down as a general principle that where work is to be done involving unknown risks of great moment and extending over long terms of years, it should be undertaken directly by the corporation or city proposing it, or, in this case, by the government direct, instead of letting it to a contractor. The reason is that no responsible contractor will undertake such work without making an allowance sufficient to cover the risks that may be met and the uncertainties which are involved. If the difficulties and expense of the work prove to be less than is anticipated, he makes an enormous profit. If, on the other hand, the contractor makes a mistake and underestimates the difficulties to be met and the cost of doing the work, the outcome generally is his financial failure, and the city or corporation is obliged to complete the work at its own expense.

Take, now, this proposition to let to the lowest bidder the work of maintaining a low-water channel in the Mississippi River from St. Louis to Vicksburg for a period of 20 years. What contractor can estimate the cost of such a work with anything like accuracy? How many years during that score will work be required? How many months in each year of low water will work be necessary? By what method can work be best done? What will it cost to do it this year? How much five years hence? How much fifteen years hence?

Is it not clear that these and similar questions which must be answered to make any real estimate on which to base a safe bid for such work can be answered only by guesses. We maintain that it is contrary to the public interest to have work which involves such uncertainties done by contract, and especially to make such a contract to continue for nearly a generation to come.

Again, Prof. Johnson says:

The only question is by what means is a successful performance to be absolutely assured? The cost in any case is but a mere bagatelle as compared to the benefits if a good navigable channel at all seasons can be relied on and obtained.

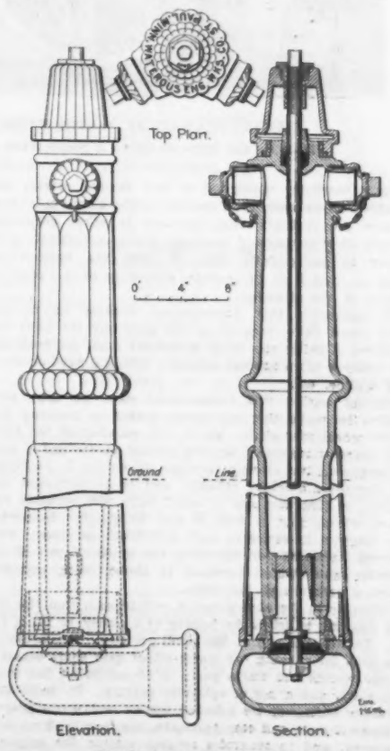
Is the cost but a bagatelle compared with the benefits? Perhaps it is, but let us not take it for granted. Let us see some fair estimate of the benefits which will accrue through reduced transportation charges—an estimate based on facts and figures and not on fancies. We can then form some idea of what the nation can afford to spend to obtain this benefit at the present time.

But even if it is found that it will pay at the present time to make the temporary channel proposed during the low-water months, who can say that it will pay ten years hence, or 15 years hence, or 20 years hence? Prof. Johnson refers to "the more expensive rail routes to the seaboard." Granting that they may be a little more expensive now, will they be more expensive ten years from now? Does he think that the reduction in the cost of rail transportation, which has gone on steadily ever since the beginning of the railway era, has come to an end?

Our position in brief is that it should, first of all, be determined as accurately as possible what benefit will accrue from the proposed Mississippi improvement at the present day. If it is found to be worth its cost, then let it be undertaken; but let not the government bind itself to continue for any long term of years a work which future changes may make unwise and uneconomical.—Ed.)

THE WATEROUS FIRE HYDRANT.

The accompanying illustration shows a two-way fire hydrant made by the Waterous Engine Works Co., of St. Paul, Minn. The hydrant has a frost case larger at the bottom than at the top, and



The Waterous Fire Hydrant.

free to rise and fall with the ground during freezing and thawing weather. The lower part of the hydrant proper tapers towards the bottom, so that in case ice forms here it will easily slide upwards when the water pressure is applied.

AN ELECTRO-MECHANICAL WATER-WHEEL GOVERNOR.

The accompanying illustration is taken from a photograph of the "Giesler" electro-mechanical water-wheel governor, which has recently been placed on the market by the Stillwell-Bierce & Smith-Vaile Co., of Dayton, O. The governor is the result of two years experimenting to obtain a governor suitable for use in connection with long distance electrical power transmissions, in which the power for the current is furnished by a water-wheel. We condense the following description from a circular issued by the manufacturers:

During our earlier experiments, our efforts were directed to making a governor entirely electrical—that is, one which should use the change in the electric current as a medium for governing the water wheel employed in generating that current; but the results were unsatisfactory. We finally concluded to accept a pair of balls for this purpose, knowing full well, however, that they would not be sensitive enough unless means could be devised for multiplying the effect incident to the slightest variation in their position. We succeeded in inventing a device which so multiplies the movements of these balls that the slightest variation in their position is instantly multiplied to any desired extent, and enables us to open or close the water-wheel gate long before the ordinary balls as used in other governors would show any sign of moving. We can arrange the governor so as to fully open or close the water-wheel gate in from 3 to 15 seconds, according to the requirements of the situation.

Furthermore, this arrangement enables us to use very small balls, because in our governor the balls are relieved of doing any work whatever; such, for instance, as lifting a valve against pressure, lifting a pawl or moving a slide, etc.

Having settled this fundamental step, we next proceeded to make this movement useful in rotating the water-wheel gate shaft. To do this we adopted the electric current, regulated by two contact points and a pair of magnets. The electric currents, as we use it, performs its functions quickly, reliably, and is of unlimited capacity, so that one pair of small balls will regulate ten water wheels just as well as one, by simply connecting the magnets in series to each individual governor. The current necessary for operating the gates of two 48-in. cylinder gate victor turbines is about three amperes under a pressure of 110 volts.

Referring to the photograph it will be seen that the entire machine is driven by belting to a pulley 12 ins. × 4½ ins. This should run at 350 revs. per min. The mechanism used for turning the water-wheel gate shaft consists of two worms and worm gears, a double-ended flat friction plate, and a set of epicyclic gearing. To make the governor noiseless, we selected worms and worm gears; to make it start and stop instantly, the face frictions are employed; and to secure a reverse motion for opening or closing the gate, which should be positive and free from pawls, ratchets, springs, etc., we adopted the epicyclic gears.

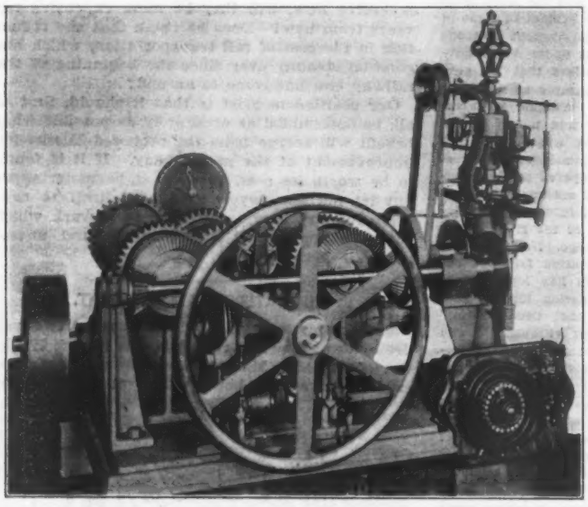
To start up a water wheel, or a train of water wheels, connected with the governor, the gate need only be opened enough to cause the wheel to turn; the remainder of opening and the entire closing of the gate can be done by power, by simply pushing the double-friction plate either way.

Two automatic stops are connected to the double-friction plate; one of them is to be set so that when the water-wheel gate is fully open, the pull of the magnet is neutralized, so that no further opening of the gate can occur; the other is to be set so that the magnets are neutralized when the water wheel is running at full speed but without load. This stop is essential, and in case of sudden relief of load, caused by blowing out fuzes or any other cause, the governor will shut down the wheel to normal speed and keep it there until the operator can shut off the water either by hand or by power.

A safety switch is also provided, which in case of a belt breaking or of any accident to the governor balls will instantly magnetize both magnets and stop all movements of the governor until the operator is ready to pull the switch to demagnetize the magnets.

A dial plate and finger, so adjusted as to indicate the exact amount of opening of the water-wheel gate is furnished for the convenience of the operator.

We are informed that the Stillwell-Bierce Co. has tested this governor thoroughly in its own shops for the past six months with entire satisfaction. The company has also booked orders for a number of the governors, and will use them on the great water-power plant, which it is about to install at the Lachine Rapids. At this plant it is the intention to have each governor control the speed of the ten wheels.



ELECTRO-MECHANICAL WATER-WHEEL GOVERNOR,
Made by the Stillwell-Bierce & Smith-Vaile Co., Dayton, O.

A SPRING-SEAT BICYCLE.

One of the most interesting new departures in bicycles which has appeared on the market this season is a machine in which the seat, crank shaft and handle-bar are supported on springs, so that they are free to move up and down independent of the main frame. The jarring of the ordinary bicycle when passing over a rough road or pavement are familiar to every rider, and pneumatic tires and pneumatic saddles can do little to ameliorate it. In the new wheel referred to, known as "the Hardy cycle," this is done away with, and the rider can go as comfortably over street crossings, humps and hollows or rough pavements as if he were sitting in a carriage.

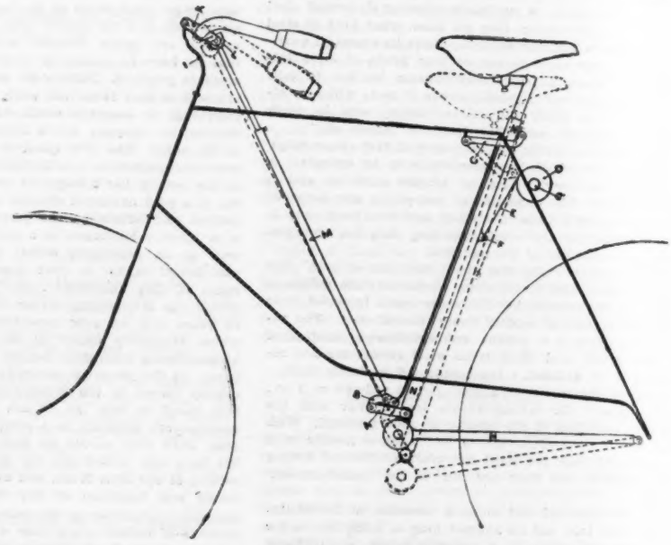
The mechanism of the Hardy wheel is shown in the accompanying cut. As there seen, the seat, crank-shaft and handle-bar are attached to an auxiliary frame, which is pivoted to the main frame by links A, B, C, but is free to move up and down independent of the main frame, which is shown by heavier lines in the cut. The spring support is furnished by a coil spring D (enclosed in a drum), to which connection is made by a steel ribbon, one end of which is secured to the seat post at F. The spring can be adjusted in a moment to suit the weight of any rider.

The crank-yoke is attached to the seat-post tube N, and to the rear forks by the tubes H. The handle-bar stem I is made in the form of a goose neck, having pivoted to it the short link K, the handle-bar being attached to this link at its middle point, while the other end of the link carries a ball joint L. The telescopic rod M connects the handle-bar link with link B in such a manner that the handle-bar follows all the movements of the saddle and cranks.

The spring when properly adjusted will permit a depression of the seat of about 1 in. under the dead weight of the rider, and a further maximum depression of 2 ins. can occur when the wheel passes over obstructions or depressions. Besides the advantage of comfortable riding and avoiding danger of injury to the spine and other parts through the jar which occurs on the ordinary wheel, it is claimed that the strain on the machine itself is less severe on account of the spring feature, just as the strain on the wheel of an ordinary wagon is much less if its load is carried on springs than if supported directly on the axles.

The Hardy cycle's weight is about that of other substantial road wheels. By reversing the seat-post clamps, which necessitates the turning of but one screw, the bicycle becomes a rigid machine. Should it be desired to strip the wheel of the "Hardy" attachments to convert it into an ordinary rigid wheel, all that is necessary is to loosen two screws to remove the handle-bar and the spring, and substitute an ordinary handle-bar.

A ladies' wheel is also made, and has been warmly approved by leading physicians. The machine is manufactured by the Hardy Cycle Co., at No. 42 West 67th St., New York city, from whom any further information can be obtained.



A SPRING SEAT BICYCLE.

THE WHITNEY GAS BILL, providing for the incorporation of the Massachusetts Pipe Line Co., has been favorably reported by a committee of the Massachusetts House of Representatives. This is the company which proposes to erect gas-saving coking ovens in Boston, and to distribute in pipes the fuel and illuminating gas made therein from Nova Scotia coal, as mentioned in our issue of Feb. 20. The bill permits the formation of a company capitalized at $5,000,000 to lay mains in any city or town of the state, subject to the assent of the local authorities and granting the right of appeal to the state commissioners in case of an adverse decision. It makes provision for all matters of doubtful interpretation, and subjects the company to numerous restrictions, granting, however, many valuable rights, among which is that of eminent domain in the same measure as it is enjoyed by railroads. The company is to be allowed to charge 35 cts. per 1,000 ft. for fuel gas delivered to any holder or distributing system; 50 cts. for fuel or illuminating gas distributed to individual consumers through a system maintained by other persons or corporations; and 35 cts., plus the cost of distribution, in cases where the company maintains its own system. This cost is to be determined by the commissioners upon the application of any 20 consumers. The measure also provides that if the company at any time reduces its prices for gas, it shall not thereafter advance them.

HYDRAULIC SUCTION DREDGE FOR THE NAVIGATION IMPROVEMENTS OF THE MISSISSIPPI RIVER.

(With inset.)

We illustrate on our inset sheet this week details of a large hydraulic suction dredge built for the Mississippi River Commission, and designed to be used in clearing away the sand bars which impede navigation in that stream between St. Louis, Mo., and Vicksburg, Miss. This dredge is worthy of especial attention on account of the novel features in its construction and also because, if it does the work it is expected to do, it will inaugurate a new era in the struggle to keep the lower Mississippi open for navigation.

Since the organization of the United States Mississippi River Commission in 1879, about $20,000,000 has been expended in works designed to protect property and improve navigation along the lower reaches of that stream. As every engineer knows, the first work done was to build levees and close slough mouths in an attempt to confine the river within limits and prevent it from swallowing up whole townships in its ramblings and from overflowing valuable plantations and destroying property. Later attention was turned to preventing the formation of sand bars and other obstructions. The sunken trees were easily handled, but the shifting sand bars proved more troublesome. The methods of dealing with them which have been adopted are of several kinds. Generally the banks have been protected with mattresses made by weaving slender poles and branches of trees or else by restricting the channel by jetties or other structures so that the current would force away the floating sand. This regulating work is being extended as rapidly as possible, but at present it relieves only a few of the worst stretches of the river.

About two years ago the question of dredging away the sand bars was considered, and some investigations were conducted to determine the probability of its success. As is well known, the sand bars in the Mississippi River are not stationary, that is, a bar seldom exists at any one point for a long time, or if it does its depth below water is constantly changing. The pilot who returns from New Orleans to St. Louis may find that some antic of the river has built an impassable sand bar where he had deep water on his down trip. This shifting of the bars made the question of the practical utility of dredges a difficult one and naturally there were various opinions among engineers. It was finally concluded, however, that if a dredge of great capacity compared with the work it was called upon to do should be built, it could be used to advantage, especially as it was found that a narrow channel dredged through a sand bar tended to keep its depth for a considerable period. The idea was, as soon as a bar formed, to set a powerful dredge at work, which should plough a channel across it in a few hours, and to keep a number of dredges patrolling the river ready to do this work at short notice.

To test thoroughly the idea the Mississippi River Commission built an experimental dredge in 1893-4 which was worked during part of the low-water season of 1894 and all of 1895. The capacity of this dredge as determined from the measuring barge was 600 cu. yds. of sand per hour delivered through 1,000 ft. of floating pipe. A full account of the experiments made with this dredge will be published in the report of the Commission for 1895.

The result of these experiments were such that early in 1895 the Commission invited dredge builders to submit plans and bids for building a much larger dredge. The conditions imposed were briefly as follows:

> The hull must have a steel frame strongly braced and so bulkheaded as to prevent sinking in case of the filling of any two compartments. It shall be covered with 5-16 in. steel plates with ⅜-in. plates at angles and exposed places, such as the water line. The deck shall be ¼-in. thick. When fully equipped for work and with a supply of coal for 24 hours operation the draft must not exceed 4½ ft. Its width must not exceed 40 ft. The dredge must also be fully and especially provided with the means of a straight up-stream movement, with one or more suctions in front which can cut to 20 ft. below the surface of the water and will make a cut wide enough for the passage of the hull of the dredge, and one or more discharge outlets through the stern, with an equal number of floating pipe lines or pipes supported by pontoons, each 1,000 ft. long and capable of and provided with means of deflection for 500 ft. from the axis of the channel. The boat may be provided with any other movement in operation, provided it does not interfere with the before described movement and the advantages justify the additional cost. The engines shall be triple expansion, of marine type, and directly connected with the main pumps.
>
> Before the dredge is paid for it shall be subjected to a test for determining the capacity of the pumps to lift and discharge material. This test shall be made by placing the dredge at work at some point on the river fixed by the United States Engineer where an ordinary river sand may be obtained at the average depth of cutting. The dredge shall discharge through 1,000 ft. of pipe each, with the pumps running at their average speed and without applying a forced draft to the boilers, into a barge fitted up for the purpose in such a way as to determine separately the respective amounts of sand and water discharged per hour. If the quantity of sand delivered is greater than 1,600 cu. yds. per hour a premium shall be paid for the dredge directly proportional to this excess, not, however, to exceed 50% of the contract price. These tests shall be carried out at the expense of the United States Government.

In response to this invitation 15 sets of plans were submitted, but of this number all but three sets were rejected on the first examination. The persons presenting these three plans were asked to submit more detailed drawings, and after a study of these the contract was finally awarded to Lindon W. Bates, of Chicago, Ill. The contract price was $172,775 exclusive of bonus or penalties. It is this dredge that is illustrated on our inset sheet and which will be described in detail in the following paragraphs. As will be seen at a glance, the principle of the dredge, that is the suction through the center of a revolving cutter, is the one familiar to engineers in the great dredges used in the Pacific coast harbors (Eng. News, Aug. 4 and 11, 1892), the Chicago Drainage Channel (Eng. News, Sept. 6, 1894), and at other places on our seaboard and inland waters. This is one of the principal features, we believe, which is claimed to be covered by the patents of Mr. A. B. Bowers, the California inventor of centrifugal pump dredges.

Figs. 1 and 2 are, respectively, a plan and sectional elevation of the dredge, showing the arrangement of the machinery. At the front end there is a battery of six cutters attached to floating ladders and operated in two sets of three cutters each. The three suction pipes from each set of cutters combine near the front of the barge to form a single suction pipe leading to a centrifugal pump. There are, therefore, two centrifugal pumps. At the rear of the pumps are the discharge pipes which lead 1,000 ft. to the rear of the dredge where they discharge. The location of the engines for operating the cutters and the various auxiliary mechanism are clearly shown by Figs. 1 and 2.

The barge which carries the machinery calls for but little mention. Its main dimensions are:

Length between perpendiculars	**172 ft.**	
Breadth	40 "	
Molded depth amidships	7 "	2 ins.
Molded depth fore and aft	10 "	10 "
Top of floor to top of beam in engine room.	**23 "**	**3 "**
Top of floor to top of beam in boiler room	15 "	3 "
Frame space	24 "	

The estimated weight of the dredge is 1,200 tons, of which the machinery composes 800 tons, the empty hull 310 tons, and the fuel 90 tons. It

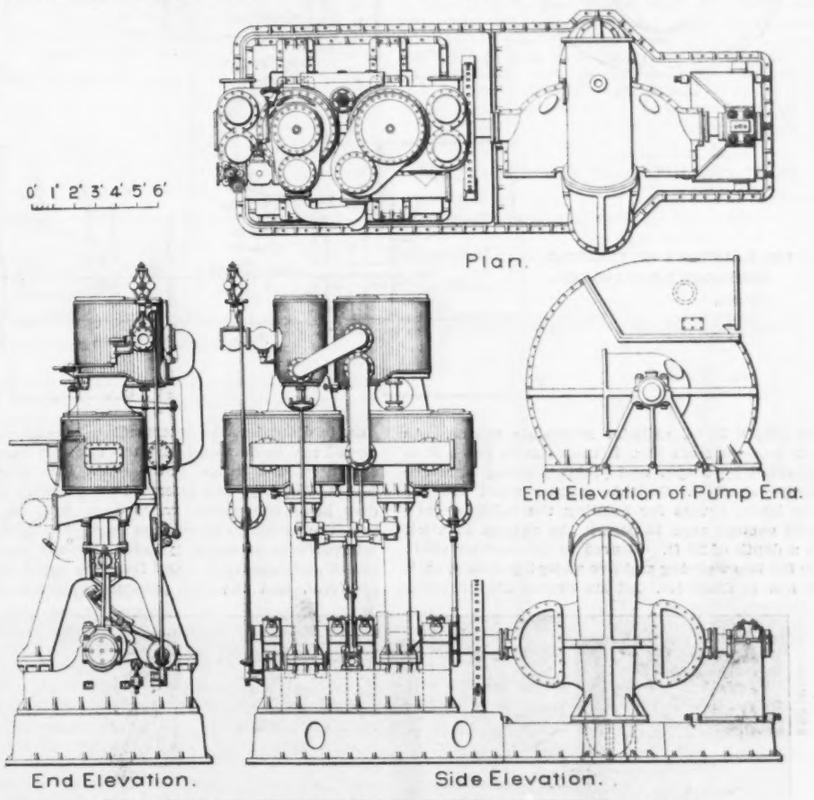


FIG. 4.—PLAN AND ELEVATION OF MAIN ENGINES AND CENTRIFUGAL PUMP.

will be noticed that water ballast tanks are provided to equalize the draft.

In describing the machinery we will begin at the front end of the dredge and work toward the stern, and the first feature of importance met with is the suction pipes, cutters, and engines for operating them. There are six 19½-in. suction pipes, each carrying at its lower end a revolving cylindrical cutter 5 ft. in diameter. Each suction pipe is contained in a water-tight pontoon buoyed up by an air chamber, and the three pontoons on each side are braced together to form a single rigid structure. There are, therefore, two sets of pontoons with three suction pipes and three cutters each. A set of pontoons is called a ladder and there are, therefore, two ladders. Each ladder can be swung up and down by means of a derrick.

The cutters are 5 ft. in diameter and each has 12 cutting blades to loosen the sand so that it can be drawn into the suction pipes. Fig. 3 shows how the revolving motion is given to the cutter with the aid of the general drawings, Figs. 1 and 2. The engine shaft A (Figs. 1 and 3) has two pinions which mesh with spur wheels on the main shaft B. By means of bevel gears the main shaft actuates the ladder shafts C, C, etc., and they in turn actuate, through bevel gears, their respective cutter shafts D, D, etc. It will be noticed that the construction allows of the ladders being swung up and down, with the aid of the telescopic joint at E (Fig. 3).

The shaft A is operated by a cross compound

14½ x 20 x 18-in. engine secured by bracket castings fastened to the bow of the hull. The engine is reversible and the speed can be changed to suit the conditions. The maximum speed which it can give to the cutters is 25 revolutions per minute.

Just to the rear of the engine for operating the cutters is the engine for raising the ladders and warping and swinging the dredge. This is a double 12½ x 15-in. cylinder reversible engine. As will be seen from Fig. 1, the counter shaft F is operated by a spur and pinion gearing from the engine shaft G. On this counter shaft are the two 30-in. drums for hoisting the ladders, each with enough rope to permit the cutters to work to a depth of 20 ft. Geared to the counter shaft are the two warping and two swinging drums, each 24 ins. in diameter. All six drums are provided with brakes and clutches and are operated from the floor of the pilot house above. The engines for operating the cutters are also controlled from the same pilot house.

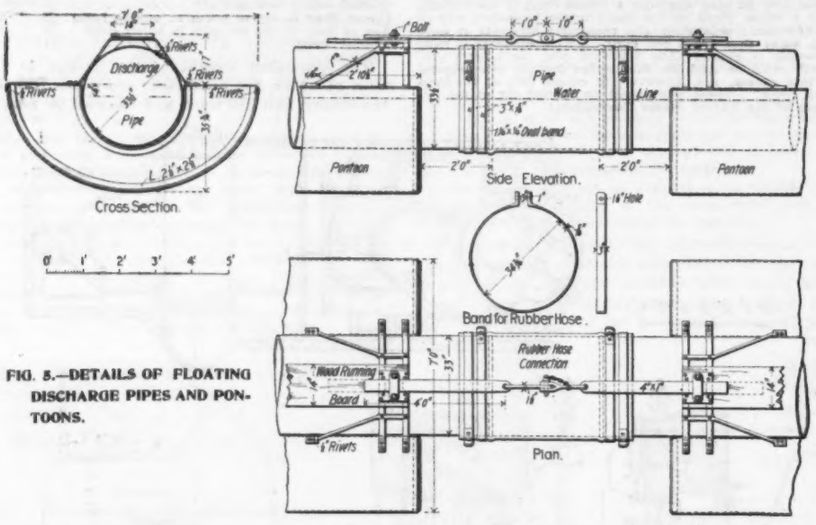


FIG. 5.—DETAILS OF FLOATING DISCHARGE PIPES AND PONTOONS.

The main pumping engines are placed about amidship. There are two of them, each with its separate pump and system of pipes, and each taking the material from three cutters. Fig. 4 shows the general design and construction of this engine. It will be seen that the engine is direct connected with the centrifugal pump. The pumps are designed to run at 175 revolutions per minute. The runners are 7 ft. in diameter and the shaft 10 ins. in diameter. The discharge is 33 ins., and the suction pipes are 33¾ ins. in diameter.

The engines driving the pumps are triple expansion and of vertical, inverted, four-cylinder, tandem type. The high pressure cylinder is 20½ ins. in diameter, the intermediate pressure cylinder 33 ins. in diameter and the two low pressure cylinders each 38 ins. in diameter. The stroke is 24 ins. The high and intermediate pressure cylinders have one piston valve each, and the low pressure cylinders two valves each. The high and intermediate pressure cylinders have a variable cut-off, adjustable by hand from the upper engine platform, and the low pressure cylinders have fixed cut-offs. Each engine is provided with a Worthington duplex air pump with jet condenser—steam cylinders 14 x 15 ins., air cylinders 19 x 15 ins.—but they can also exhaust into the atmosphere. It will be noticed that a 10-ton traveling crane runs on the deck house over each engine.

The battery of four 375 HP. Heine boilers is located aft of the pumping engines. These boilers are of the well-known water tube type, made by the Heine Boiler Co., of St. Louis, Mo. In order that the muddy river water may be used in the boilers it is filtered. Two 6 x 11 ft. filters and a 42 x 42-in. precipitator with a conical bottom 22 ins. deep are used. The two filters are connected and take water from the precipitator which in turn takes water from the well. The water receives a coagulant as it enters the precipitator and the coarse matter sinks to the conical bottom, where it is drawn off. The water with the coagulant enters the filters and passes through a layer of crushed quartz to the clear water chamber. The capacity of the filter plant is about 250 gallons per minute. It was installed by the Pittsburg Filter Co., Pittsburg, Pa. From the filters the water passes to a feed-water heater, where it is heated by the exhaust steam from the various auxiliary engines. The main engines are condensing. Figs. 1 and 2 show the relative location of the filter plant, boiler feed pumps, etc.

At the stern of the dredge there is a double 8 x 10-in. cylinder, three-drum hoisting engine, for the purpose of raising and lowering the two vertical pivot spuds and the metal pushing spud. The engine shaft is double geared to the drum shafts. The two vertical spuds are of oak, 40 ft. long, and shod with steel, and are used to hold the dredge in place, or as a pivot on which to swing it when in operation. The pushing spud is operated by a 15-in. x 7-ft. steam cylinder.

Figs. 1 and 2 show the location and construction of that part of the discharge pipe connected to the dredge. To convey the material the required 1,000 ft. to the rear of the dredge, a 33½-in. steel pipe is floated on the water by means of steel pontoons. The construction of these pontoons is clearly shown by Fig. 5. To connect the rigid pipe on the dredge with the floating pipe there are curved pieces of pipe 7 ft. long, made up of ten sections, with telescopic joints. The other end of the curved pipe is connected to the floating pipe by a rubber joint, but the inner end is bolted to the fixed pipe on the dredge. Sometimes it is desired to discharge the material toward the bow of the dredge, and in this case a semi-circular connecting pipe is used.

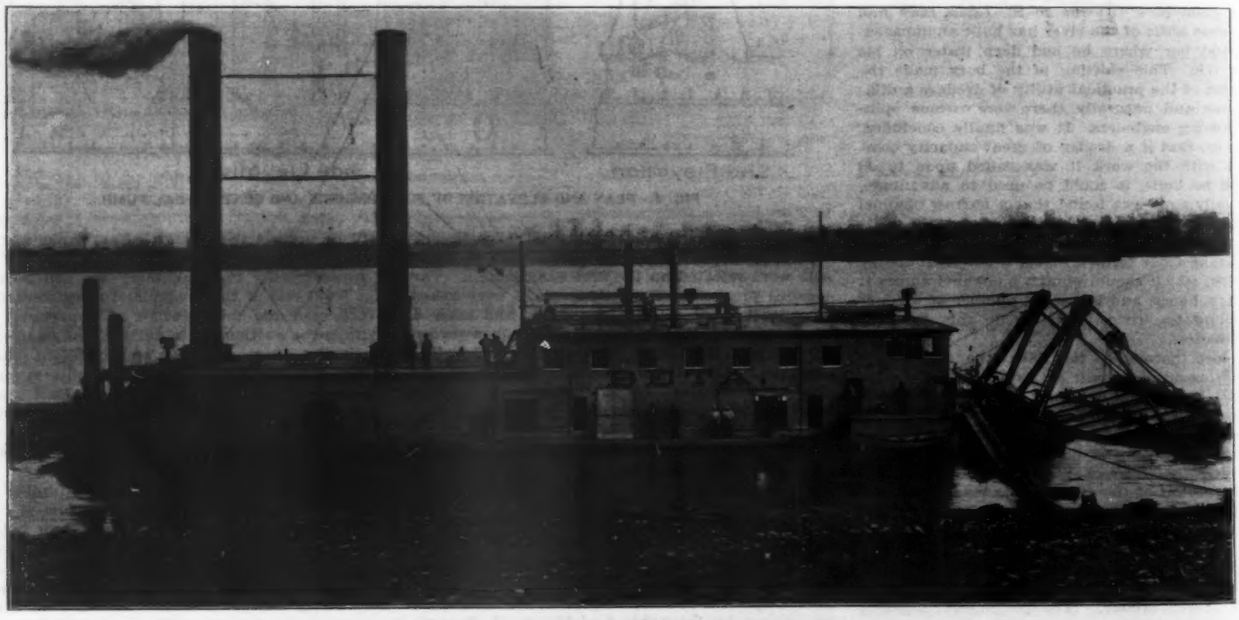


FIG. 6.—VIEW OF DREDGE COMPLETED AND READY FOR WORK.

Each 1,000-ft. length of floating pipe is made up of 12 pontoons, of which four are 50 ft. long, and eight 100 ft. long. The pontoons are made of 3-16 in. steel, with four water-tight compartments for the 50-ft. lengths and six for the 100-ft. lengths. The floating discharge pipe is made of ¼ in. steel. The pontoons are held together with coupling bars, and the pipes are coupled by means of a rubber hose, as shown in Fig. 5. When the pipe is empty the pontoons draw about 14 ins. of

water, and when the pipe is carrying its proper load of sand and water the water line is about 2 ins. from the deck of the pontoon.

The pontoons and pipe were tested at the works, painted inside and out with black asphaltum paint, and shipped on flat cars in 50-ft. lengths. This necessitated some field riveting on the 100-ft. pontoons. Altogether 250 tons of steel were used in the pontoons. The contractors were the Springfield Boiler & Mfg. Co., of Springfield, Ill.

The dredge is lighted by 40 20-c. p. incandescent lights and two 400-c. p. search lights, supplied by an electric plant on board. There are also a blacksmith shop, drill press and other necessary tools for repairing.

The foregoing completes the description of the machinery and appurtenances of the dredge proper, but in operation it is accompanied by a tow boat tender, equipped with apparatus for pulling snags, warping lines, etc., and by a quarter boat for the men.

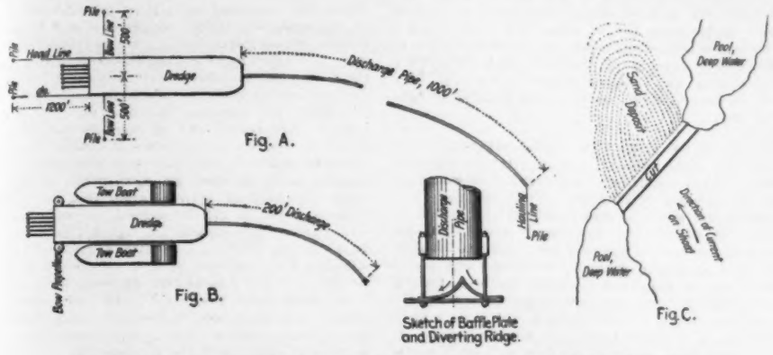
The dredge can be operated either up or down stream, with the cutters bow-on or trailing, and also by swinging it on one of the vertical spuds as a pivot. Operating in the last way the maximum swinging cut below water level measures $22\frac{1}{2} \times 5\frac{1}{2} \times 235$ ft. Without forward movement the machine can therefore handle about 1,300 cu. yds. of material. The operating force consists of a captain or operator and assistant, chief engineer and assistant, oiler, water tender, spud engineer, four firemen, and six deck hands, or altogether 17 men.

The contractors for the dredge machinery and appurtenances not yet mentioned are: Hull, machinery and erection, Maryland Steel Co., Sparrows Point, Md.; centrifugal pumps, Robert Poole & Sons, Baltimore, Md.; other pumps, H. R. Worthington & Co., New York, and Stilwell-Bierce and Smith-Vaile Co., Dayton, O.; feed-water heater, Taunton Locomotive Mfg. Co., Taunton, Mass.; nickel steel gears and castings, Fowler Foundry Co.,; valves, Ludlow Valve Mfg. Co., Troy, N. Y. The machinery was designed by Mr. Axel Sahlin, M. Am. Soc. M. E., Superintendent Maryland Steel Co. We are indebted to Mr. Sahlin, the Springfield Boiler & Mfg. Co., and Mr. Lindon W. Bates for the matter from which this article has been prepared.

As operated in the tests made by the government engineers the forward motion of the dredge was obtained by hauling on two head lines, each about 1,200 ft. long, and the lateral swing was controlled by two bow lines attached to piles about 1,000 ft. apart, as shown in Fig. A. The discharge was through 1,040 ft. of pipe, leading to deep water, and at the end of the discharge is another system of lines and piles. This method of manipulation entails very considerable delay in shifting lines and driving piles; a delay estimated at as much as 50 per cent. of the time actually required in making any certain advance. The piles and controlling lines also interfere with navigation, and under certain conditions stoppages to permit the passage of boats and tows would be unavoidable and frequent.

In view of the enormous capacity of this dredge and its consequent rapid progress, features which have earned for the inventor a bonus of $86,387.50, Mr. Bates proposes an entirely different method of handling, as shown in Fig. B. For the piles and lines he would substitute two powerful stern-wheel steamers, one lashed to either side of the dredge and both under the control of the captain of the dredge. To each side of the bow of the dredging boat would be attached a propeller wheel, properly caged and protected, and operated by electric motors. In connection with the towing boats these propellers would serve to constantly keep the cutters to their work and control the lateral motion of the dredge.

In makng a cut across a bar between any two pools of deep water, he would shorten the discharge pipe to about 200 ft., and discharge the sand to the leeward or down-stream side of the cut, as shown in Fig. C. As discharged from the end of the present 1,040 ft. of pipe the outflow had an observed average velocity of about 21 ft. per second, while directly at the end of the dredge, discharging free this velocity, is about 45 ft. per second; and it is fair to assume that it would be about 40 ft. at the end of 200 ft. of pipe. With this latter velocity of discharge, directed towards the lee of the cut, the sand should be spread over a very considerable area and out of the way of the channel. To control the movement of the end of the shorter discharge-pipe, without the aid of piles and lines Mr. Bates suggests an ingenious application of the bucket of the Pelton water wheel. He would place across the end of the discharge, and a short distance from it, a baffle-plate, held by rods to the pipe; sliding upon the baffle-plate would be two other curved plates, united at their centers and with the apex ridge towards the issuing stream of water and sand. The lateral motion of the apex would be under the control of a man stationed on the end-pontoon, and by shifting the apex to one side or the other of the pipe center the lateral motion of the end of the discharge-pipe would be controlled by the impinging current.



PRESENT AND SUGGESTED PLANS OF OPERATING MISSISSIPPI RIVER DREDGES.

The general results of the late official test of the capacity of this dredge were as follows:

Results of Government Tests on Ordinary Mississippi River Sand.

Date.	Forward speed, ft. per min.	Length of discharge, ft.	Per cent. of solid discharge.	Rate per hour, cu. yds.	Cu. yds. sand per I. HP. per hour.	Remarks.
Mar. 10...	5.5	1,040	34.58	6,354	2.46	
" 12...	4.5	"	22.80	4,988	1.98	
" 13...	5.0	"	36.40	7,798	3.04	
" 16...	4.0	"	21.92	4,850	1.84	
" 20...	...	"	17.43	3,872	1.82	6% gravel
" 21...	...	"	29.00	6,217	....	
" 23...	...	"	28.35	6,327	....	
" 24...	...	"	21.50	5,083	....	

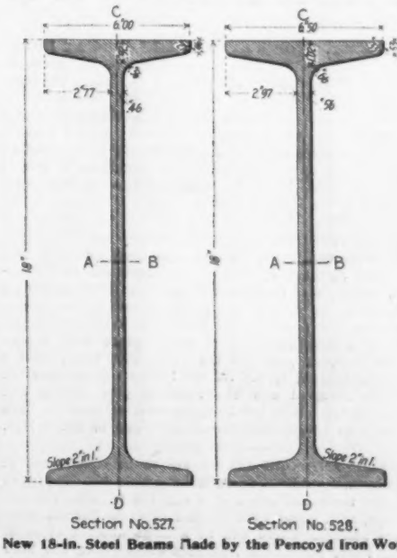
YARD TESTS OF AIR BRAKES.*

In interchange yards where air brake plants are located the air brake cars should be charged immediately after placing protection flags in position. The inspection of air brake apparatus should be made at the same time that the general inspection of train is made. After the inspection is completed a service application should be made to determine that brakes are in proper working order and to adjust piston travel if necessary. In order to obtain a service application, which is essential in making tests, an ordinary ¾-in. or 1-in. cut-out cock having a 3-16-in. hole drilled through one side of plug and also body of cock, converting it into a three-way cock, should be connected with the hose used in testing. The test is completed after an examination has been made to insure that all brakes have properly released. The test as described at yard plants when cars are received from other lines need not be repeated on the line of the road, further tests being made by road engines when trains are made up, except in cases of cars placed in trains at intermediate stations and which have not received a yard test within a stated period. Cars given the regular yard test should be marked in some manner so that they can readily be distinguished by inspectors at intermediate points from cars that have not been tested. The test as outlined above does not appear necessary at all division terminals where air brake plants are located, but in cases where practicable the air brake cars should be connected to yard pressure so that in the regular inspection any defects that exist may be detected. In addition to the tests referred to all cars, foreign and home, when in shop or on repair tracks, should have cylinders and triple-valve cleaned and oiled, if the work has not been done within the prescribed time, and in all cases brakes must be tested on each car separately, as it has been shown in various discussions on the subject of use and maintenance of air brakes that comparatively slight defects may result in accidents of more than ordinary proportions.

*Extract from report of the Committee on Air Brake Testing and Inspecting Plants, presented at the March meeting of the Central Railway Club, Buffalo, N. Y.

THE PENCOYD IRON WORKS NEW 18-IN. BEAMS.

The A. & P. Roberts Co., proprietors of the Pencoyd Iron Works, Philadelphia, Pa., send us blueprints showing the elements of two new 18-in. steel beams, which they are now prepared to roll,



New 18-in. Steel Beams Made by the Pencoyd Iron Works.

and we reproduce them herewith. This beam is designed to fill the rather wide gap which has hitherto existed between 15 and 20-in. beams.

Elements of 18-in. I-Beams, Made by the Pencoyd Iron Works.

Section No.		528	527
Size in ins.		18	18
Area in sq. ins.		19.7	16.2
Weight in lbs. per ft.		67.0	55.0
Moments of inertia..	Axis A. B...	973.5	809.0
	Axis C. D..	30.29	20.82
Square of the radius of gyration.	Axis A. B..	49.42	49.94
	Axis C. D..	1.54	1.28
Radius of gyration..	Axis A. B..	7.03	7.07
	Axis C. D..	1.24	1.13
Resistance or "section modulus".		108.2	89.9
Add to resistance for each additional lb. per ft.		0.88	0.88
Co-efficient in net tons for greatest safe load, dist'd. (16,000 lbs. fibre stress).		576.9	479.4
Add to previous co-efficient for each additional lb. per ft.		4.7	4.7
Co efficient for deflection.	Distributed load	.00000161	.00000193
	Centre load	.00000264	.00000317
Maximum load in net tons.		47.8	32.8

THE METRIC BILL, recommending the adoption of the metric system of weights and measures in the United States, and favorably reported by the Committee on Coinage, Weights and Measures, meets with opposition in the House. It was opposed by Congressmen Bartlett, of New York, and Parker, of New Jersey. The only reasons advanced against it were that England had not adopted it, and there was no assurance that she would, and "it was no better than the old system." Both objections were met by a denial on the part of those advocating the bill, but a motion to order the bill to engrossment and a third reading failed by a vote of 65 to 80. The House adjourned without further action.

THE DRAINAGE CANAL CONTRACTORS, by a late order of the Chicago Drainage Board, must keep all completed sections of the canal pumped dry until the work is accepted by the State Board of Commissioners and is ready for the admission of water from the lake. As the canal cannot be finished for 20 months, and it may be two years before it is officially accepted, there is considerable objection to this class of work by the contractors. But the board holds 12½% of the contract price until the sections are accepted, and will endeavor to force compliance.

A PROJECTED BRIDGE AT SYDNEY, New South Wales, is chiefly interesting from its horizontal plan. The city of Sydney is separated by a wide channel from some very active and growing suburbs. It is proposed to bridge this space by a cantilever bridge of the Firth of Forth type, with 1,843 ft. between the centers of main towers. But as the existing streets in the two cities would meet at considerable angles, if produced, the engineer proposes to build the arms of each main cantilever on the street lines as now established and connect these by the suspended span of 300 ft. The estimated cost is $5,400,000.

A BELT LINE RAILWAY crossing all the railways reaching the New Jersey water front of the Hudson River, opposite New York city, has been suggested by Mr. Erastus Wiman in order to facilitate freight transfers and increase terminal facilities by giving access to the new terminals on Staten Island. The line would start at a junction with the West Shore R. R., near Little Ferry Station, pass through Passaic and Elizabeth, and connect with the Baltimore & Ohio R. R. bridge to Staten Island.

A SAFETY STOP FOR ELECTRIC CARS AT DRAW-bridges is to be tried on the approach to the drawspan of the Central Viaduct, at Cleveland, O., where the terrible accident occurred on Nov. 16, 1895. About 150 ft. from the draw is a conduit with a counterweighted cable, having at one end a heavy steel plate. As the draw is opened this plate is raised through the slot of the conduit, and if a car is not stopped by the motorman it will be gradually stopped by the counterweight on the cable attached to the striking plate.

AN AUTOMATIC BUMPING POST designed to prevent street cars from running into open swing bridges has been designed by Mr. P. J. Kroehnke, of Thiensville, Wis. The device consists of a shaft extending back from the end of the bridge about 10 ft. underneath the middle of the car track. At each end of this shaft is a spur gear, one of which gears with a rack on the bumping post and the other with racks on the end of the swing span. As the bridge swings open the shaft is revolved and the bumping post raised, and as the bridge closes the bumping post is lowered. The device is of course installed at each end of the bridge.

A SLIP AND ORE DOCKS are to be constructed at Huron, O., by the Wheeling & Lake Erie Ry. The work includes the construction of a slip 150 ft. wide and 800 ft. long, with about 1,650 ft. of dock front and six acres of ore storage. There will be a large amount of sheet piling work, for which Wakefield sheet piling has been specified. The work will be in charge of W. J. Sherman, Chief Engineer, Wheeling & Lake Erie Ry.

A FLOATING STEEL DOCK, at Norfolk, Va., is proposed by a "Docking, Shipbuilding and Machine company," now seeking a charter. The dock contemplated would be 400 ft. long by over 70 ft. wide, and would be built in two sections so that either could be used independently of the other. With it would be a complete plant for shipbuilding and repairs, including a thoroughly equipped machine shop. The plans were made by Mr. Frank B. King, a naval architect and marine engineer, and the capital stock mentioned is $500,000.

THE SUPERIMPOSED TURRETS FOR BATTLE ships are formally adopted by the Navy Department as the result of late experiments and tests. The battle ship "Indiana," in her late voyage from Port Royal to New York, fired her 8-in. guns in the upper turret and observed the effect upon the men in the 13-in. gun turret below. The report is that while the men in the sighting hoods below had no very comfortable position, there was not enough shock or smoke to interfere with the perfect working of the heavier guns. The 13-in. guns of the "Indiana" were also fired several times, to test the smoke effect on the men in other batteries. Aside from burning holes in her woodwork with powder-grains and "dishing" some steel battle-hatches which were too large, no damage was done by the tremendous concussion of the large guns. Secretary Herbert, in a letter to the Senate Naval Committee, briefly states the reasons for adopting the double turrets on the new "Kearsarge" and "Kentucky." The plan permits a better horizontal range of fire; it secures vastly greater protection to the 8-in. guns; it permits the installation of a superior rapid-fire battery; it secures a heavier fire in every direction; it saves the cost and weight of four 8-in. guns with their armor, substructure, turning engines, etc. The saving in cost under this head, supposing the armor for these 8-in. turrets to be the same as in the "Indiana," is $248,000. The total weight of the double-turret emplacement is less than that for one emplacement for a 13-in. gun on board the "Indiana," and it is less than that in some English ships by 200 tons. The one valid objection to the double-turret plan is that if the turning gear of the large turret be displaced it will stop the rotation of four guns. As this turning gear is protected by the best armor in the ship, the chances of its injury are diminished to a minimum.

THIRTY-KNOT TORPEDO BOATS would be built by the Herreshoffs, according to their letter to the Secretary of the Navy, for $215,000 each. They would not exceed 225 tons displacement and to attain a maximum speed of 30 knots per hour, the builders would be compelled to use the highest quality of material obtainable. They propose a boat which would favorably compare with the best, or fastest foreign built torpedo boats or torpedo boat catchers.

THE TOWER OF THE NEW PHILADELPHIA CITY Hall is to be further altered with the view of reducing the weight on the foundations, and Architect Powell asks for an appropriation of $132,000 for this purpose. The heavy foundation walls, it appears, were laid in lime mortar instead of cement, and this mortar is still soft and permits settlement. It is now proposed to remove a heavy semi-circular projection originally intended for a stairway which was not built, and to replace this by a straight wall and a balcony. Certain pillars on the north entrance, now badly cracked, are to be replaced, and these pillars have already been relieved of an enormous weight by replacing solid brick walls on the fifth and sixth floors with light iron partitions. Useless openings in the lower floors of the tower are also being filled with solid masonry. This same settlement has already cost a large amount of money in removing cracked masonry at the junction of the tower and wings.

TESTING STEAM ENGINES to prove the fulfilment of a guarantee is not as common as is the practice of making guarantees. If testing were more common, not only would guarantees be made less recklessly than they are, but engine-building practice would be improved, by the gradual abandonment or improvement of the more imperfect types and designs. A recent case in which a test showed the failure to fulfil the guarantee, and which will probably lead to the improvement of one make of engine, occurred at Minneapolis, Minn., as described in the newspapers of that city on April 8. Three 125 HP. tandem compound engines, we presume non-condensing, were placed in the new court house, the requirements of the specification being a water consumption not exceeding 24.5 lbs. per I. HP. per hour, and a regulation within 1%. The results of the tests of the three engines gave the water consumption respectively at 31.05, 30.43 and 27.88 lbs. and the regulation 4.4, 5.4 and 5.4%. The engines were run at about their rated power and were furnished with steam of 125 lbs. pressure, dried by passing it through a separator. It would be interesting to know what water consumption they would have recorded under loads considerably above and below their rating.

THE USE OF ELECTRIC POWER in factories is rapidly widening. An installation has recently been made by the General Electric Co. in the mills of W. J. Dickey & Son, Baltimore, Md. It includes two 90 HP. moderate speed generators, bolted to a horizontal water wheel. The current is transmitted about 200 ft. to the third story of a woolen mill where it will be used to operate motors and furnish light. In this third story 36 60-in. woolen cards and four mules are to be placed, the cards being arranged in three rows, 13 to a row, with a line of shafting to operate each row. The motors will be placed either on top of the roof beams or will be suspended from the same beams by iron slings and will be connected to the line shaft by a belt. Two of these line shafts will be operated by two 25 HP. slow speed motors. For the operation of the mules a 20 HP. moderate speed motor will be connected to the shafting. The General Electric Co. is also about to put an electrical equipment in the factory of the Norway Shoe Shop Co., of Norway, Me. Seven non-synchronous multiphase motors aggregating 100 HP. will be used. The current will be taken from a 250 K-W. three phase generator recently set up in its station by the Norway Electric Light Co. Still another large establishment equipped by the same company is the new bicycle works at Middletown, O., owned by the Miami Cycle & Mfg. Co. This concern employs 550 to 600 operatives and turns out about 200 bicycles per day. The system of transmission employed is the General Electric Co.'s monocyclic system, which permits the economical operation by a single-phase alternating current of motors and lights from the same circuit without interfering with the steadiness of the lights. The current to operate this plant is transmitted by wire about a mile from the power house of the Middletown Electric Light & Power Co., at a potential of 1,100 volts. At the factory the current is reduced to a potential of 115 volts, and is distributed to nine motors and to the incandescent lamp circuits. There are three 30-HP. motors, three of 20 HP., one of 10 HP. and two of 5 HP. In general, the motors drive line shafts to which are connected the various machines of a department. The motors are of the induction type, without commutators, collected or moving contacts. It is of interest to note that the same generator at the power house which furnishes the current for this factory also lights 500 to 600 incandescent lamps, scattered through the town, besides 600 in the opera house.

IRON PIPE FOR ELECTRICAL CONDUITS has recently been suggested as a cheap and efficient substitute for the patented interior conduits now used in first-class electric wiring installations. At first these interior conduits were tubes made of some fibrous insulating material, but these were found to be not sufficiently durable and were especially liable to injury by nails being driven into them. The next step, therefore, was to protect them with a brass armor, and as even this was found not secure enough, the present style of conduit was adopted, which is simply an iron pipe with a layer of insulating material on its interior. Mr. A. C. Dobbs, in "The Electrical Engineer" of April 8, urges that this insulating material might as well be omitted, as, according to the best practice, the conduits are regarded as merely raceways for the wires, and as high a grade of insulation is required on the wire as if it were not in a conduit. Moreover, in the present iron conduits, the inside insulation, when moist, swells, get pulpy, and remains so for weeks. The pipes are of necessity much larger than plain conduits and a common fault among engineers is to use wire with insufficient insulation in order to reduce the size of the conduit. Chances for injury to insulation of wire are as many in the one case as the other; plain iron conduit can easily be cleaned of burrs and rendered perfectly smooth; in case of a collection of moisture it is soon dry; much smaller sizes may be used and it is not only cheaper in first cost but in expense of laying. Another point of great importance is that the use of ordinary iron pipe for conduits would so reduce the cost as to make the use of conduits much more general in place of cheaper and less secure systems of wiring.

THE NEW CALCIUM CARBIDE WORKS at Niagara Falls is reported completed and in operation. The Acetylene Light, Heat & Power Co. is the new name of the corporation owning the plant, the former name being the Calcium Carbide Co. From a description in a recent issue of the Buffalo "Times" we abstract the following:

The Niagara Falls Power Co. supplies the electric power to drive the plant, 1,000 HP. being used. An alternating current is furnished at 2,200 volts, and is transformed to 110 volts. The capacity of the works is 5 tons of calcium carbide per day. The building is divided into five principal parts—a crusher room, a furnace room, a transformer room, a storage room, and a laboratory. Coke and lime, in the proportion of 75 lbs. of pure lime to 100 lbs. of pure carbon, are separately crushed in a Dodge crusher and a rolling mill, the coke going through a 50-mesh sieve. They are then thoroughly mixed, and conveyed by a screw conveyor and an elevator to the furnaces on the second floor. There are four crucibles in the furnace, each holding 800 lbs. of the mixture. The crucible forms one electrode and the carbon "pencil" the other. A few inches of ground coke are put in the crucible, and the carbon pencil is then let down on it, closing the electric circuit and making an arc of intensely high temperature. The carbon is gradually drawn up as the mixture is dumped in. The chemical reaction immediately begins by which the calcium of the lime and the carbon of the coke unite to form calcium carbide. The mixture is allowed to remain in the crucible from 3 to 8 hours according to the amount of the ingredients and of the current. A mixture of 1,750 lbs. of lime and 1,130 lbs. coke, making a total of 2,880 lbs. will produce 2,000 lbs. of calcium carbide. The estimated cost is $23 per ton. The product of the factory is all to be shipped for use in Pennsylvania. It will be shipped in air-tight drums.

AN ACT TO REGULATE BUILDING CONTRACTS, passed by the Pennsylvania legislature last year, applies to such contracts as have, either incorporated or separate, a stipulation that no mechanics' liens shall be filed against the building, by the contractor or by any sub-contractor, material man, etc. The act provides that no contract for the erection of the whole or any part of any building, and no stipulation separately made as part of any such contract, whereby it is sought to deprive or hinder a contractor, sub-contractor, material man or other person from filing or maintaining a mechanic's lien, for work done or material furnished to such building or to any part thereof, shall operate to defeat the right of any sub-contractor, material man or other person to file and maintain such a lien, unless such contractor or the stipulation shall specifically covenant against such lien by sub-contractor or other person, and unless said stipulation shall be put in writing and signed by the parties thereto prior to the time authority is given to the principal contractor to proceed with said work, and unless said contract or said stipulation shall be filed with the prothonotary of the county where the land lies for record within ten days after its execution.